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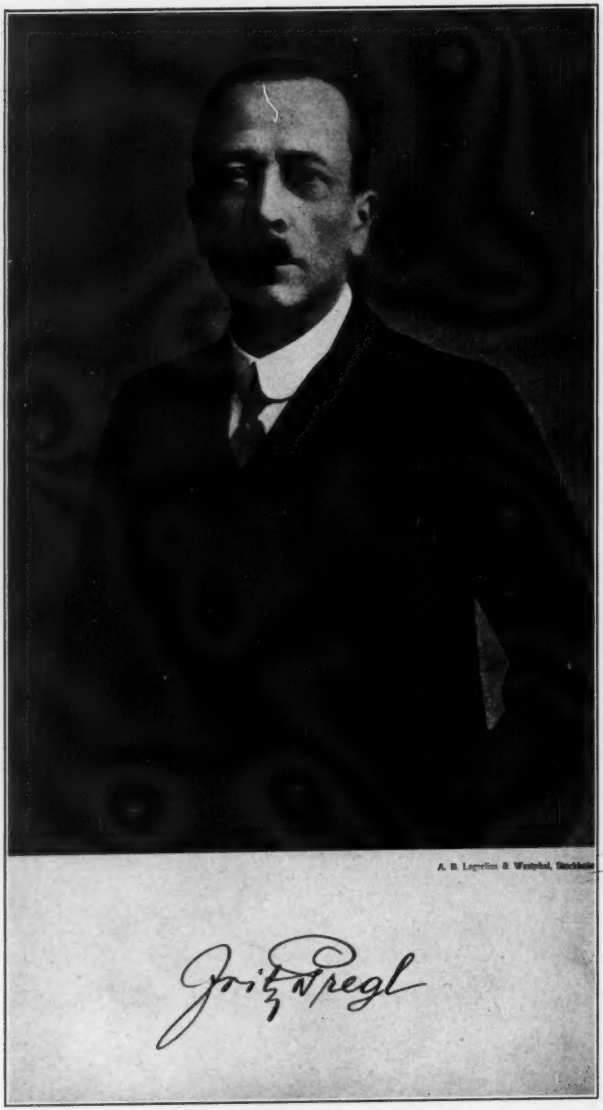

A. B. Lagrelius & Westphal, Stockholm

Jos. Fr. Pregl

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EDITOR'S OUTLOOK

Fritz Pregl, 1869-1930

ON FEBRUARY 27, 1911, Fritz Pregl presented before the Deutsche Chemische Gesellschaft in Berlin an experimental lecture, publicly demonstrating certain applications of microanalytical methods to organic compounds which he had been working out during the previous year in his physiological research at Innsbruck. The adaptation of microanalysis makes a fascinating story when the simplicity of its origin is associated with the magnitude of its results. Pregl, then professor of medical chemistry at the University of Innsbruck, while working on the bile acids, at the investigation of which his most important studies in physiological chemistry were directed, obtained in one of his experiments a disappointingly small yield of a product he wished to analyze and was faced with the alternative of repeating the work at the expense of a large additional amount of the raw materials or of giving up the analysis. Such a choice was only a matter of routine, but Pregl broke with that routine and, inspired and stimulated by the success of Emich and his associates in inorganic microanalysis he gave to physiological, organic and biochemistry a new method which by its unprecedented reduction of materials and time has opened the way to the solution of many problems which could not even have been attacked in any other way yet known to science. At Pregl's suggestion, the only existing microbalance possible to his purpose was further refined by its manufacturer, Kuhlman of Hamburg, and Pregl himself utilized his art as a glass-blower and his extraordinary manipulative dexterity in the preparation of suitable apparatus. After three years of untiring attempts at coördination of mechanical conditions with his broad fundamental knowledge of chemistry, Pregl was able to carry out before the Naturforscherversammlung in Vienna a complete and accurate determination of an organic compound by micro methods.

This demonstration and the publication of his method in the previous year in Abderhalden's "Handbuch der biologischen Arbeitsmethoden" carried Pregl's name far and wide, and very shortly scientists from all quarters of the world, the skeptical and the hopeful, began to arrive at the Graz laboratory to which Pregl had returned in 1913, to be initiated into the newest of scientific mysteries. Pregl made no secret of them; he became the willing and eager teacher of all who came, but in this field of which he was the sole master, he was also still the enthusiastic student, intent upon the refinement of his method, upon the extension of its usefulness, upon its adaptation to new determinations, upon its correlation with previously existing methods, upon its possibilities in the hands of the youthful and inexperienced as well as in those to which it came as a new and valuable tool in an old craft. Suffice it to say of his success, that since it earned the Nobel prize in chemistry for 1923, it has also figured in three later awards of the same distinction, for

the work of Wieland, Windaus, and Hans Fischer, who received the Nobel chemistry prizes of 1927, 1928, and 1930, is much indebted to Pregl's method.

It was not until 1916 that Pregl, unwilling to stop short of perfection, yielded to the persuasion of his colleagues and assembled a complete account of his notable work in his "Monographie der quantitativen organischen Mikroanalyse." The value of this book is attested by the fact that it has run to its third edition and was within a short time of publication translated into French, English, and Russian.

Pregl's early scientific career was an admirable preparation for its later orientation, though it gave no presage of it. He took his degree in medicine from the University of Graz in 1889 and although he practiced the profession to some extent, mainly as a specialist in ophthalmology, he exhibited very early an interest in physiological chemistry which his teachers encouraged by appointing him even before he received his degree as an assistant to Rollett in the Physiological Institute at Graz. Here he remained until 1904 when, having filled for a year the chair left vacant by the death of Rollett, and feeling the need of new contacts and of insight into other fields, he made a student trip to Germany during the course of which he spent a semester in the physiological laboratory of von Hüfner in Göttingen, and worked also with Ostwald at Leipzig and with Emil Fischer in Berlin. He returned to Graz in 1905 as assistant to K. B. Hofmann in the Medical Chemical Institute, where he remained until called to the professorship of medical chemistry at Innsbruck in 1910. In 1913 he was back again at Graz, appointed to succeed Hofmann as head of the Medical Chemical Institute, which he continued to direct while he lived. Pregl was not a native of Graz, having been born at Laibach, 100 miles away, on September 3, 1869, but it had been his home since his student days, and after his return to his alma mater in 1913, none of the flattering offers that reached him could serve to win him away from it again.

In addition to the world-wide renown which came to Pregl, his work as an eminently successful and well-beloved teacher and director of the Medical Chemical Institute earned for him a less known but more deeply felt distinction, which made his associates, students and friends regard as all untimely his unexpected death in Graz in his sixty-second year on December 13th last.

The JOURNAL OF CHEMICAL EDUCATION acknowledges with gratitude the courtesy of Mr. Sederholm, managing director of Nobelstiftelsen, Stockholm, Sweden, in providing the accompanying photograph of Dr. Pregl, and that of Dr. Hans Leib, associated with Pregl at the Medical Chemical Institute of the University of Graz, for much of the material on which the foregoing sketch is based.

Scientific Attitude

NO DOUBT all of us have had opportunity at one time or another to observe the behavior of inexperienced but progressively inclined parents who undertake to rear children "scientifically." Unfortunately for the fair name of science and for the results sometimes achieved by its supposed guidance, many people seem to imagine that scientific child-rearing consists in buying a book and in following scrupulously and in minute detail the more or less dogmatic directions therein set forth. The question one may well raise is whether or not such procedure is in any sense scientific, even though the guidebooks profess to be based upon the findings of science.

This pseudo-scientific school of thought has its counterpart in the educational field, as Professor Brim has pointed out in the *Journal of Educational Research*.[1] A quotation with which he illustrates his point seems so divinely made to order for the purpose that it is worth reproducing here. The words are those of the author cited; the italics are Professor Brim's.

> It is this educational science which should *dictate everything* that is done by anyone. If the work is done *in strict obedience to educational science*, then it is rightly done. . . . *The science is the authority.* There is no other. There is to be obedience. But it is the obedience to science.[2]

Aside from its extreme credulity as to the present achievements of educational science, the point of view expressed is a special case of a too-general misapprehension as to the essential virtue of the scientific method. There has been an over-emphasis upon the quantitative aspects of science, with a consequent tendency to magnify the supposed exactitude of science. It is but a short step from here to the establishment of authority and the justification of dogmatism—both deadly foes to the true spirit of science.

The really significant contribution of science to the progress of civilization has not been in the ability to say that this or that is true or untrue beyond all question of a doubt. It has not been in the ability to measure two quantities and to say that one or the other is greater or smaller by precisely so much.

Science has attained surprising exactitude in some of its measurements, but its prime contribution to intellectual progress has been in its repeated demonstration that authority is not infallible; that dogmatism is both foolish and immoral; that no idea stands beyond the need of periodic re-examination. Above all things science has placed a premium upon the open and inquiring mind. It is in this sense that science makes its greatest contribution to the art of education.

[1] Orville G. Brim, "Research That Prevents Research," *J. Educ. Research*, **22**, 161–71 (Oct., 1930).

[2] Franklin Bobbitt, "Scientific Principles Applied to Supervision," *Report of National Association of Penmanship Teachers and Supervisors*, **1928**, p. 12.

It is unfortunate both for science and for many of its would-be satellites that the term has become a shibboleth. We have the "science" of education, the "science" of salesmanship, and, God save the mark, the "sciences" of astrology and numerology. It is to be expected that any shoddy quackery will attempt to masquerade under the name of whatever is at the moment respectable and honored. It is pathetic and regrettable, however, that an art which has every claim to honor and respect in its own right should imitate the quacks in this.

Education is not a science in the Kelvin sense, and in the very nature of things it can never become so. It can adopt the scientific attitude and it can, to a certain extent, make use of scientific technics, but it is in essence an art and it will lose rather than gain by trying to become anything else.

The painter of any but the modern schools makes use of the science of geometry in planning his perspectives; he makes use of the science of optics in selecting tones for his lights and shadows; he makes use of the science of anatomy in depicting the human form; he makes use of chemistry (perhaps unconsciously) in the selection of his pigments and other materials; but he has the good sense and the self-respect not to call himself a scientist. He is an artist and you affront his self-esteem by calling him anything else.

Is it to be understood from all this that the writer aligns himself with the reactionary school and seeks to cast discredit upon educational research of all kinds? On the contrary. He seeks only to point out that faddists and extremists are more likely than not to be fools; that he who sails under any flag but his own is at best a hypocrite and at worst an ass; and that the worshipper of dogmas, whether theological or scientific, is a sheep.

When the educational experimenters confront us with some new and startling conclusion, let us ask how they arrived at it. Did they in fact measure the thing they claimed to measure? If so, is the factor measured of sufficient importance among the many to be considered to indicate the advisability of a change in our procedure? Is there any evidence that the proposed change will result in improvement? When all these things are so, let us heap honors upon them and do as they direct.

When they tell us that a certain objective is purely aspirational, let us ask whether they have been able to show that we are chasing a will-o'-the-wisp or whether they have merely been forced to admit their inability to construct a suitable technic of measurement. If the one, let us humble ourselves and mend our ways; if the other, let us preserve a good heart and continue for the present to aspire.

In short, let us eschew prejudice. Educational research is neither all blah, on the one hand, nor undiluted wisdom from on high, on the other.

SAPPHIRES

J. W. Howard, State University, Missoula, Montana

The sources, mining, sorting, grading, and properties of natural sapphires are described. Details of the preparation of synthetic sapphires are given and the methods of distinguishing natural and synthetic sapphires discussed. Sapphires rank high among gem stones, their value being enhanced by proper cutting. The chief commercial uses are as a bearing material in electrical instruments and as watch jewels.

. . . . . .

Introduction

Old Mother Nature has turned out crystallized aluminum oxide in three different forms from her laboratory; namely, (1) the transparent or translucent gem stones with names varying according to their colors, these colors being due chiefly to small amounts of other metallic oxides; (2) common corundum which is transparent and with no very pronounced color, generally bluish grey to black; (3) emery or granular corundum which is mixed with more or less magnetite or hematite.

The chief gem stones are the ruby and sapphire. The oxides of chromium are responsible for the red color of the ruby, while iron and titanium oxides give the varying colors found in the sapphire.

The origin of the term sapphire seems to have been "lost in antiquity." There has been some dispute as to whether it is a Grecian word taken from the Island of Sapphire in the Arabian Sea, or whether it is of Semitic origin, the Island being named for the gem. Others have assumed that although the term was used by Moses it was imported into the Semitic language.

The sapphire or σάπφειρος of Theophrastos, the *saphiros* of Pliny and the ancient Greeks and Romans, is believed to be the lapis lazuli (a very complex silicate of beautiful blue color) of the present day.

The name undoubtedly suggests blue, the best tints being royal blue, velvet blue, and cornflower blue. However the name is now also applied to crystallized aluminum oxide of white, lilac, yellow, golden, pink, and yellow-green shades. The paler shades are described as feminine in contrast to the deeper, richer, masculine varieties. The name "oriental" is also prefixed, not as an indication that the gem came from the East, but as a method of distinguishing it from other minerals having the same color. For example a yellow sapphire may be called an oriental topaz, a green sapphire an oriental emerald.

We also have the stellate or asteriated sapphire, the star being due to a regular arrangement of small channels or twin lamellae parallel to six sides of the prism. Light is reflected from the basal plane of the interior through these channels. Some stones also possess a fibrous or silky structure.

American Museum of Natural History, N. Y.
A STAR SAPPHIRE FROM CEYLON

Source

Siam is the original home of splendid sapphires. Sapphires are plentiful and rubies are rare in Ceylon while the converse is true in Burma. One faultless stone in Burma weighed seventy-nine and one-half carats. However, India has given the best yield of gigantic sapphires, the largest ever reported weighing nine hundred and fifty-one carats and is said to have been in the treasury of the King of Ava in 1827. An image of Buddha cut from a single sapphire is on exhibition in the Mineral Gallery of the British Museum of Natural History.

The Zanskar range, especially near the Simla Pass in the Himalaya mountains, is noted for the yield of beautiful sapphires. Small sapphires have been found near Somabula Forest in Rhodesia and dark-colored ones in Australia.

In all of these places the sapphires are found mixed with some type of gravel or alluvial deposits.

North Carolina and Montana have, to date, reported the greatest deposits in the United States, although there have been occasional "finds" in other states. The yield has been very good from the famous Corundum Hill and Cowee Creek in Macon County, North Carolina. One of the finest specimens of emerald green—a stone four by two by one and one-fourth inches—came from this locality.

The Montana deposits were discovered by prospectors in their gold washings as early as 1865. The deposits at the Eldorado, Emerald, and other bars on the Missouri river, near Helena, are gravel bars ten to fifty feet thick resting on slate or granite, and part of bluffs extending fifty to one hundred thirty feet above the river.

American Gem Mining Syndicate

SECTION OF FOURTEEN-MILE FLUME BRINGING WATER FOR HYDRAULIC MINING OPERATIONS

On Cottonwood Creek near Deer Lodge and the West Fork of Rock Creek near Philipsburg the gravel-sapphire deposit is down by the side of the stream, and contains sapphires of various colors.

The other large deposit is in the Yogo Gulch near Utica, Montana. Here the sapphires occur in a dyke of trap rock outcropping through limestone. The material in which the sapphires occur varies in appearance and character from hard rock down through different gradations, some two hundred and fifty feet deep, to the soft yellow oxidized clay into which it finally decomposes. This dyke is a mile and a half long and appears to the ordinary observer as a perpendicular crevice filled with the above-mentioned material. According to geologists this phenomenon was produced by the trapped material being pushed up from below. It is easily available for removal. This deposit has gained distinction because it has yielded so many sapphires of the famous "cornflower" blue shade. The color is evenly distributed, making matching easy, and is bright and effective by artificial light. Gems valued at over $2,500,000.00 and industrial stones worth $500,000.00 have been removed from this mine. The finest single specimen sold for $1600.00.

Mining

Mining operations vary with the nature of the material surrounding the sapphires. If this is semi-hard rock it would be impossible to crush it without also crushing the sapphires. Hence the "pay dirt" after being brought to the surface is exposed on extensive floors to the disintegrating effects of the atmosphere, sometimes for months. A stream of water is then turned on the floors and the material carried into sluice boxes. Across the bottoms of these boxes iron riffles (bars) are placed which catch the sapphires, owing to their greater specific gravity, while all the lighter mud, gravel, and non-disintegrated pay dirt are carried into dams to undergo further weathering preparatory to rewashing.

In case, as on Rock Creek, the gravel-sapphire deposit is weathered material, and a deposit along the stream, a strong stream of water can be turned on it directly and the material washed down through sluice boxes, any large rocks being forked out at the head of the boxes. Water is brought through a fourteen-mile flume to give the necessary "head" for the operations on Rock Creek. It makes a very picturesque scene and of striking resemblance to placer mining for gold.

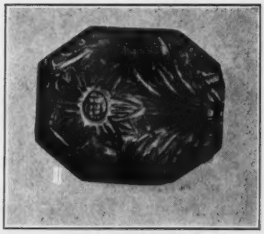
Sorting and Grading

As the separation obtained in the sluice boxes is not clean and complete some further means of separation has to be used.

One method is to feed gravel-sapphire material across some sort of

jigging table over which flows a countercurrent of water. This makes a further use of gravity, as the sapphires settle and the gravel is washed away.

A very ingenious method of separation is to make use of static electricity. In an electrical field there is a force acting on the sapphire crystal tending to move it in the direction of the positive pole, while the gravel is unaffected. Hence if the mixture is dropped through an electrical field the sapphires are drawn to one side and separated by a properly placed division in the bottom of the tube.



American Museum of Natural History, N. Y.

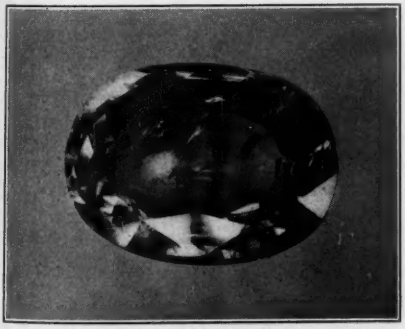
ENGRAVED BLUE SAPPHIRE FROM CASHMERE
Weight $14^{7}/_{32}$ carats.

Final sorting and grading according to size and quality is a "hand picking" task and performed by experts.

The final product will be in one of three forms: (1) crystals in the form of hexagonal prisms terminated by rhombohedrons and pyramids or tubular crystals in which the basal spine is largely developed; (2) transparent pieces of more massive corundum; or (3) nodules of finer, cleaner material of the general shape of pebbles.

Synthetic Sapphires

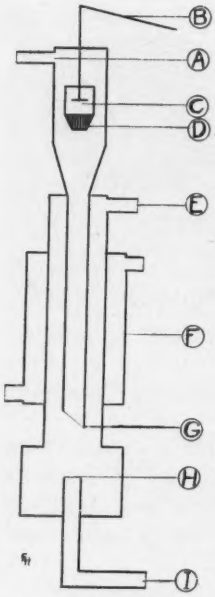
The simple chemical composition of sapphires gave encouragement to attempts to prepare them synthetically and these have met with very marked success. Ammonium hydroxide is added to a solution of highly purified ammonium alum and the resulting precipitate of aluminum hydroxide is filtered off and ignited, thus converting it into aluminum oxide (Al_2O_3). In order to get the desired shades, other oxides are mixed with this aluminum oxide before fusion. Chromium oxide gives reds and pinks, nickel oxide a yellow, vanadium oxide a yellow-green, iron and titanium oxide a blue. Doubtless other secret coloring agents are used. Any potassium impurities give a brown color.



American Museum of Natural History, N. Y.

BLUE SAPPHIRE FROM KANDY, CEYLON
Weight $158^{23}/_{32}$ carats.

Getting a satisfactory blue caused the greatest difficulty. In the early experiments cobalt oxide diffused unevenly, making splotches, and magnesia was added in the hope it would act as



VERNEUIL BLOWPIPE

a fluxing material and overcome this. The desired color resulted but the stones had all the physical characteristics of spinel (an aluminate of magnesium). The product was called "Hope Sapphire" from a fanciful analogy with the famous blue diamond of the Hope collection. Substituting lime for magnesia gave a better stone in that it was not affected by artificial light. It was finally discovered that a mixture of five-tenths per cent titanium oxide, one and five-tenths per cent magnetic oxide of iron, and ninety-eight per cent aluminum oxide gave a good blue sapphire. A blue can also be obtained by using only the titanium oxide.

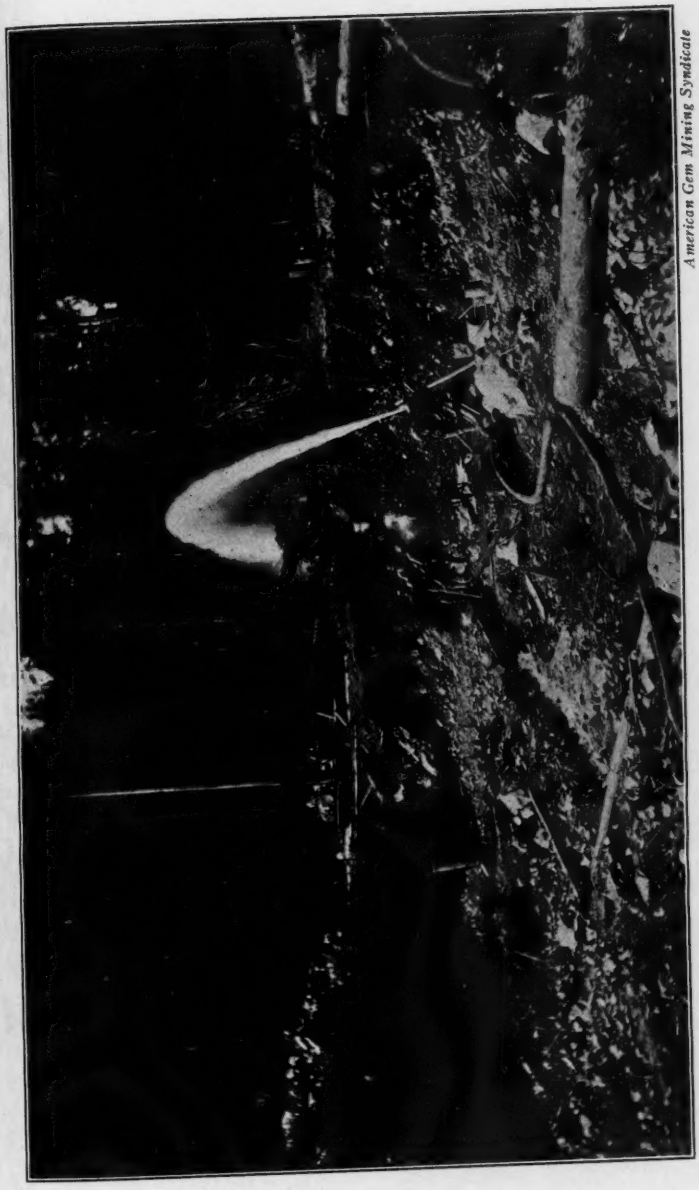
The apparatus for carrying out the fusion is known as the Verneuil blowpipe and is shown in the accompanying sketch. The finely ground mixture of oxides is placed in *C* and by means of the tapping device *B* is slowly forced through the sieve *D* and is fused as it emerges from the tube at *G* by an oxy-hydrogen or oxy-coal gas flame. The oxygen enters at *A* and the hydrogen or coal gas at *E*. Temperature control is aided by use of the water jacket *F*. The fused oxides collect on the fire clay support at *H*. The tapping device may be run by an electromagnet or a cam. The growth of the gem is watched through a red glass screen. The gas pressure is regulated so as to prevent the pedestal from melting and yet keep the area of the drop in contact with the pedestal as small as possible, thus preventing flaws due to partial cooling. The ideal condition is to have the top of the drop melted but not boiling. The pedestal is slowly moved down as the drop grows in size. The two gases are shut off promptly and simultaneously when through and the product removed when cool. The product is pear shaped and known as a boule. It takes six to twelve hours to produce a boule weighing one to five grams (five to twenty-five carats). One attendant can operate about ten machines.

Each boule is a crystalline individual with crystallographic axis parallel to the core. They can be divided longitudinally through the central core into halves suitable for cutting. In fact, they sometimes split in this way during cooling.

BOULE

Distinguishing Synthetic and Natural Sapphires

The natural and synthetic sapphires have practically identical indices of refraction, specific gravities, hardness,



American Gem Mining Syndicate

HYDRAULIC MINING FOR SAPPHIRES ON ROCK CREEK, MONTANA

dichroism, and chemical composition. Various analyses show the natural to run 97.51 to 99.26% Al_2O_3; traces to 1.89% Fe_2O_3, and up to 0.80% SiO_2; while the synthetic run 99.83 to 99.85% Al_2O_3; traces of Fe_2O_3, TiO_2 0.11 to 0.13%, and no SiO_2. This makes chemical analysis as a distinguishing method almost impossible and anyway the gem would be ruined as a result of the analysis. A number of other schemes have been used for identification.

The synthetic often show, under the microscope, structure lines due to the thin parallel layers resulting as the boule is built up.

If some of the powder does not fuse, cloudiness may result. But this is avoided in the best stones.

The microscope may also reveal rounded and elongated air bubbles, when the boule is immersed in a liquid of the same index of refraction. But these are sometimes confused with microscopic needles of rutile in some natural stones.

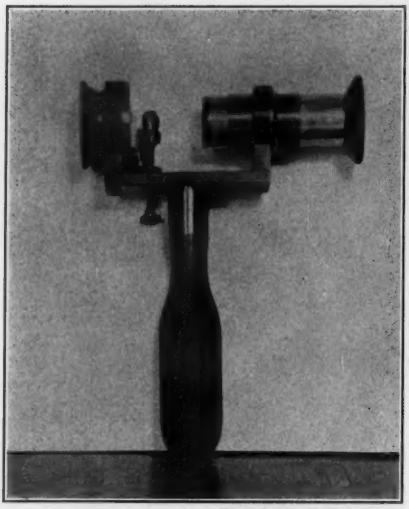


Photo by R. F. Peterson

A DICHROSCOPE WITH GEM IN PLACE

Due to rapid cooling, boules sometimes develop internal cracks called feathers.

As it is much easier to cut natural stones so that the table of the stone is perpendicular to the vertical crystal axis, the synthetic ones are often cut at random and show dichroism when *properly cut* natural ones do not. The special instrument for detecting this is called a dichroscope. If a dichroic mineral is held in this instrument and light transmitted through it, two differently colored squares, corresponding to the colors transmitted by the two rays in the mineral, will be seen at the eyepiece. The dichroscope contains a rhombohedron of calcite which by its property of double refraction separates the two rays emerging from the mineral and the eye sees a patch of color for each ray. A ruby will show two shades of the same color. In a deep-colored sapphire the two colors may be ultramarine blue and a bluish or yellowish green. Dichroism is only eliminated from natural stones by proper cutting.

It is evident in all these tests that they have decided limitations and may fail in cases of carefully prepared and skilfully cut synthetic sapphires

General Electric Company

MINERAL SUBJECTED TO CATHODE RAYS, SHOWING LUMINESCENCE

or poorly cut natural stones. Hence the discovery that the Coolidge cathode-ray tube could be used as a positive means of identification was very welcome. It is also of interest to note that this was the first commercial application of the tube.

In this method trays of sapphires, both natural and synthetic, are exposed in a dark room to the powerful rays of the tube for a few seconds. All glow or radiate colors while exposed to the rays, but when the rays are turned off the natural stones cease to glow whereas the synthetic stones continue to glow. In addition to sorting sapphires, the rays also help determine their source. If Montana sapphires are mixed with those from Australia, characteristic differences in the glow would be evident. There is even a different hue in the glow of synthetic sapphires from different factories. There is one particular kind of natural sapphire which does not glow at all, which test immediately shows its origin.

Imitation Sapphires

There is also an imitation sapphire on the market made from stones of poor color. These stones are split across the girdle and reunited by a Canada balsam cement containing coloring matter. If these are placed in oil the surfaces become visible. Boiling water, alcohol, or chloroform will dissolve the cement and the stone will fall to pieces.

Uses

Sapphires are used as gems, meter and watch jewels, wire-drawing dies, and abrasives.

Its value as a gem is determined by its rarity, hardness, color, index of refraction, and luster. With the diamond designated as having a hardness of 10 the sapphire ranks next to it with a hardness of 9, and above the spinel ruby and topaz, each of which have a hardness of 8. With an index of refraction of 1.7678 to 1.7598 with Li = red as standard, it ranks below the diamond and a couple of varieties of garnet, but well above most of the other common gem stones. Blue is the preferred color for gem purposes and if this color is evenly distributed throughout the stone and is bright and effective by artificial light, the value is further enhanced.

Color and color effects in the stone may be either helped or destroyed by the methods used in cutting it for gem purposes. The yellow tint given by the extraordinary ray of some sapphires can be avoided by cutting the stone with its table facet at right angles to the prism edge which is the direction of single refraction.

A stone may be colorless except for a single spot of blue, but if cut steeply and the spot brought to the base, the effect may be the same as if the stone were uniformly colored, all the light emerging from the stone having passed through this spot.

The "lapidary" (stone cutter) uses metal plates or wheels for slitting, discs or laps for grinding and polishing, the former being set vertically and rotated around horizontal spindles. the latter set horizontally and rotated around vertical spindles. Three styles of cutting are used on sapphires, the step, cabochon, and brilliant.

The step cut is also called a trap or cushion cut and is a flat cut with one or more rows of facets arranged parallel to the girdle.

The cabochon cut simply consists in smoothing or rounding off the stone as illustrated in the star sapphire picture. It has a number of variations.

The brilliant cut is the one most commonly associated with the diamond. The octahedron is its basis. Five-eighteenths of the height is removed from the upper and one-eighteenth from the lower portion. The upper portion is then called the crown or bizet and the lower the pavilion or base. Facets usually varying from fifty-six to eighty in number are then cut on the crown.

American Gem Mining Syndicate

PIT FACE FROM WHICH SAPPHIRES ARE WASHED
Sluice boxes are at lower left.

A very popular cut with sapphires is to have a brilliant cut crown and a step cut base.

The sapphire has always been in demand for watch jewels, but the rapid advance of the electrical industry has greatly increased its demand as a bearing material. One large electrical manufacturing company alone states that it uses more than a million and a half per year as jewels for bearings in meters and other delicate electrical instruments.

More than 20,000 watch jewels are sold annually.

Sapphires are prepared for jeweled bearings as follows: each stone is given a rounded form and pierced in the center, the drill hole being made of such size that the steel axle or pin for which it is intended will fit into it accurately. The bed of the stone is a small cylinder of soft gold alloy. The cylinder is fixed on a lathe, then the workman picks up the stone with the moistened finger and inserts it in the cylinder while the latter turns the axis of the lathe. With a pointed tool he next presses against the edge of the revolving cylinder thus forcing the soft metal to cover and protect the sapphire to such an extent that it appears imbedded in a metallic cushion. A drill is now inserted in the metallic coat of the cylinder from the opposite side of the lathe and a hole is drilled in this way, of exactly the same size as the hole in the stone itself.

Surely no other product can lay better claim to that ideal combination of "beauty and utility" than the sapphire.

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The author is especially indebted to DR. J. P. ROWE of the Department of Geology of the State University of Montana for much valuable material used in this article.

Boron Fluoride in Wood Alcohol Is Acid Strong as Sulfuric. A solution in wood alcohol of the chemical boron fluoride is as strong an acid as sulfuric. This fact was reported recently to the chemical section of the American Association for the Advancement of Science meeting in Cleveland by Prof. J. A. NIEUWLAND of the University of Notre Dame. He concludes that the solution forms a separate compound.—*Science Service*

X-RAYS IN THE SERVICE OF CHEMISTRY AND INDUSTRY IN 1931

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The primary purpose of this paper is to present in concise form the present status of X-ray science, particularly as it has been applied to problems of chemistry and industry. A brief résumé is given of the fundamental basis of X-ray examination of materials, both by radiography for gross structure and by diffraction patterns for the analysis and ultimate fine structure. The type of information and improvements in technic are indicated. As evidence of the practical value of X-ray testing research, more than fifty actual examples, chosen at random, are cited of uses and achievements in the solutions of problems in which the scientific information supplied by the diffraction of X-rays in materials has proved of readily recognized value. These examples merely suggest the manifold possibilities in assisting the chemist and technical engineer in pure research and in the manufacture of every kind of commodity.

. . . . . .

Only a very few years ago any discussion of X-rays was limited to academic laboratories of physics, where the interest was in deducing atomic structure models from wave-length measurements, and to hospitals where modern medical diagnosis found its most powerful aid. But now a visitor to numerous large industries manufacturing commodities of every description may be conducted proudly to a laboratory devoted to X-ray research and testing. He may hear difficult problems discussed intelligently in terms of "diffraction patterns," "random or preferred orientation," "strain asterism," and the like.

Here is but another evidence of the advance of a fundamental pure science to the aid of the practical manufacturer.

The great keynote of any such science is to relegate empiricism and guesswork into the realm of the past. The achievement of X-ray science lies in the rational improvement of processes and materials and the solution of problems unapproachable by other methods, simply by supplying the facts in a genuinely ultimate sense. It is the purpose of this brief paper to present some examples chosen at random of actual practical results, without attempting to explain in detail the X-ray technic or methods of interpretation. These may be found in more extended treatises.

Since X-rays are like ordinary visible light except that they have wavelengths perhaps $^1/_{10,000}$ as long, it follows that they should be reflected, refracted, diffracted, polarized, etc. It also follows that they should penetrate matter opaque to visible or ultra-violet light, and that they should be associated with a far finer subdivision of matter than is apparent by optical observation. Upon the first of these fundamental differentiations depends the whole science of radiography of which the most familiar application is the observation of broken bones, bad teeth, etc. Here the X-ray

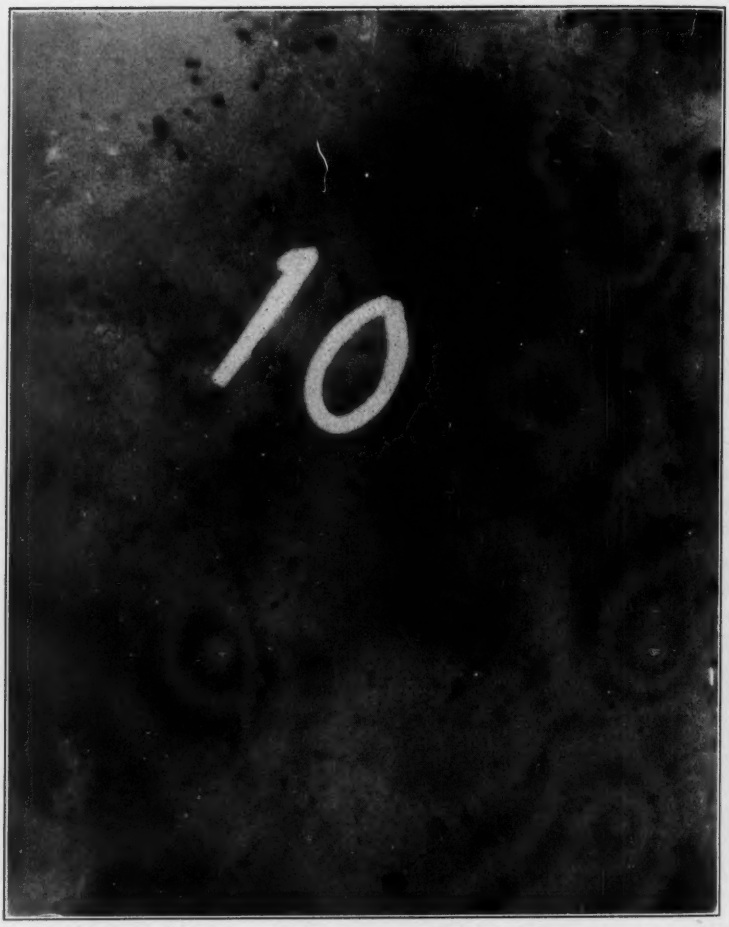


FIGURE 1.—RADIOGRAPH OF CAST STEEL SHOWING INTERNAL IMPERFECTIONS OF SEVERAL TYPES

beam is differentially absorbed by the matter in the path depending upon relative absorbing powers or densities. Thus on the photographic film or on the fluorescent screen will be observed a shadowgraph of the object in which bones or foreign objects on the interior of the body stand out in bold relief by contrast with the more easily penetrated surrounding soft tissues. What this application to medical diagnosis has meant to the welfare of mankind is beyond estimation.

Obviously any object whatsoever might be similarly tested as to interior

gross structure and inhomogeneities, with the great advantage that the specimen need not be cut up or harmed in any way. The technic and the entire apparatus can be exactly the same as that employed in medical diagnosis. The following radiographic applications are actually made in American industries:

Castings of Every Description for Internal Cracks, Blowholes, Cavities, Inclusions, and Segregations. (Figure 1.)—Foundry technic in many instances has been scientifically revolutionized in order to eliminate defects. Routine radiographic testing is now generally employed for every piece, particularly where subsequent expensive machining is involved.

Welds for Pipe Cavities and Imperfect Bonding.—Here again with the aid of this method of testing welding technic has been vastly improved. In certain cases, such as for welded oil-well drill-rod, assurance of soundness was previously impossible and the sale actually prevented.

Automotive and Aircraft Parts such as pistons, cylinders, propellers, for imperfections where failure would endanger life. In such cases radiographic testing is absolutely essential. Manufacturers who do not employ it are subjecting users to needless risk and the products should be considered inferior.

Some very interesting photographs have just arrived from Germany showing railway cars fitted up with complete X-ray apparatus for radiographic testing. These cars are run alongside locomotives upon which steam chests, fire boxes, and various other parts may be examined for imperfections and incipient failure.

Ball Bearings for Internal Imperfections.—Unwittingly a large manufacturer was turning out a high percentage of imperfect ball bearings until the surprising results of a radiographic test led to improvements in the process to a practically one hundred per cent perfect product.

Other Examples of Testing for Imperfections

Rubber tires for imperfect bonding to cords and reclaimed rubber for metallic foreign bodies.

Golf balls for imperfect centering of core.

Radio tubes for imperfect centering and position of electrodes.

Complicated glass, hard rubber, and bakelite pieces of various kinds with internal seals, etc., for improper fabrication.

Wood for cracks, wormholes, rot, knots, embedded nails, etc., as employed in aircraft frames, special lumber, telephone poles, etc.

Railway ties for compression under tie plates.

Shells and cartridges for improper filling, imperfect timing adjustment, etc.

Metal capillaries for non-uniform bore and clogging.

Insulated wire for breaks, and porcelain insulators for imperfections.

Coal for presence of slate and efficiency of "jigging" process.

In the field of art the examination of old paintings and art objects for alterations, and retouching; excellent radiographic laboratories are now to be found in the Field Museum, Metropolitan Museum, Fogg Art Museum, Harvard University, and elsewhere.

Thus the ability to see on the inside of any object without altering or destroying the specimen is obviously a great boon to industry just as it has been to medical diagnosis.

But X-ray science does not stop with radiography. The foregoing applications are logical manifestations of the property of penetration of objects opaque to ordinary light. The other fundamental prediction from the nature of X-rays is that they should be associated with a far finer subdivision of matter than is ordinarily apparent. A series of finely ruled parallel lines on glass will diffract white light with the appearance of a spectrum of colors. Gratings with very much closer spacings than can be mechanically produced would be necessary for X-ray diffraction under ordinary experimental conditions, if these rays are like light except in wave-length.

To Determine Crystal Structure

It took over fifteen years to discover that all solid crystals are perfect three-dimensional gratings for X-rays by virtue of the fact that they are built in remarkably organized fashion with the atoms lying on equidistant parallel planes whose spacings are of the same magnitude as X-ray wave-lengths. Since every crystal has a very characteristic ultimate architectural plan depending on the kind and number of atoms, the diffraction pattern registered on a photographic film when a fine beam of X-ray passes through a specimen, will be characteristic of the particular material. Thus if the wave-length of the X-ray is known, as is usually the case, then the actual structure of a crystal acting as a grating may be deduced. Since the information involves the position in space of atoms to form a solid, we are thus employing X-rays to "look" down into the fine structure of matter far beyond the powers of any microscope, with the aid of apparatus such as is shown in Figure 2.

X-ray diffraction science is, therefore, at the same time *sub*-microscopic and *super*-microscopic. By crystals is meant not only large single specimens with perfect geometric faces as in calcite, sugar, salt, or diamond, but also practically all solid materials. Examples of solid substances where there is no rational orderly arrangement of atoms on planes are extremely rare.

It is possible to analyze not only single grains but also extremely fine-grained aggregates. Even liquids which are usually classed as truly amorphous produce diffraction interferences indicating some kind of ordered

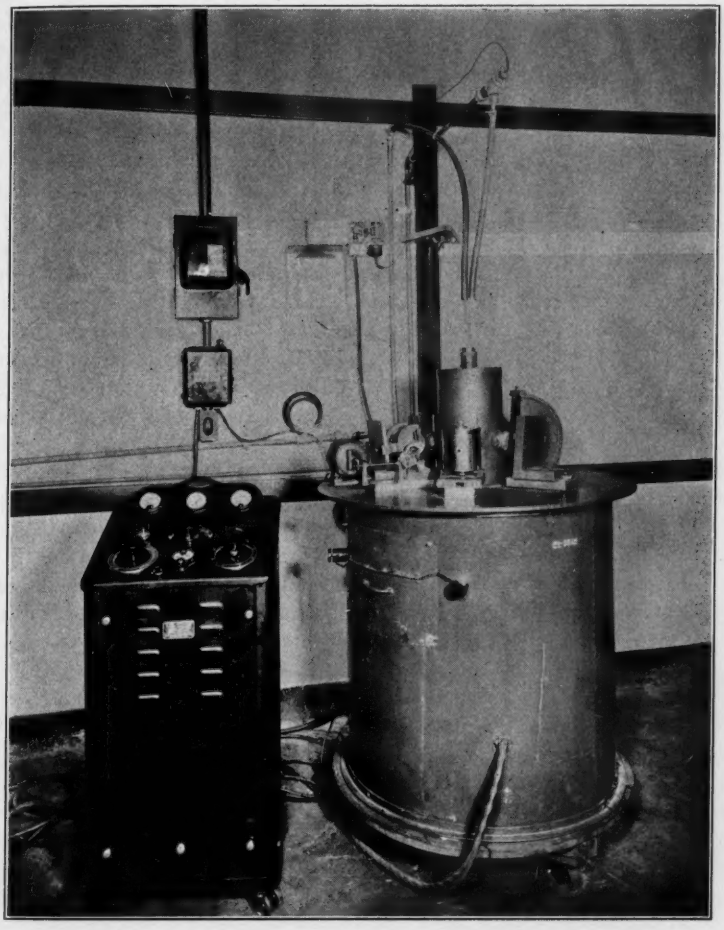


FIGURE 2.—HOME-MADE MULTIPLE DIFFRACTION UNIT SHOWING VARIOUS TYPES OF CAMERAS AND CASSETTES

arrangement of molecules even though this may be transitory. There is thus no limitation of the kinds of matter which may be examined in this super-microscopic sense, though of course the more distinctly crystalline, the simpler the interpretations.

One of the most interesting new developments is in the interpretation of X-ray scattering at very small angles. A measurement of this fogging in the laboratory of Sir C. V. Raman in Calcutta has led to the evaluation of molecular dimensions in sugar solutions and molecular weights of polym-

erized and colloidal solutions of gum arabic, tannic acid, soap, and amorphous constituents of coal and resins. This scattering is of course a powerful method of study of gas molecules. Thus even with no kind of definite organization in matter, fundamental information can still be gained concerning ultimate structures.

The X-ray chemist, therefore, employs a powerful, new, fundamental tool in the solution of some of his most difficult problems. For the diffraction pattern of his unknown specimen is, with interpretation based upon known physical laws, the symbol of a vast visual power reaching down to the atom. He discovers the smallest entity in space which has all the properties of the large visible crystal, which represents the solid building plan. For solid iron, for example, this is a cube less than three hundred millionths of a centimeter on a side with an atom of iron at each corner and one at the center. From the pattern he measures grain size in both the microscopic and sub-microscopic ranges. He detects internal strains which affect the parallel orderly grating structure. He identifies a given chemical element or compound with a given pattern and thus discovers impurities, chemical changes, and unsuspected reactions of all kinds.

Detection of Minute Changes

He discovers that fabrication such as rolling or drawing of metals profoundly influences the X-ray pattern, so that he may quantitatively deduce the mechanism of re-orientation in preferred directions of the crystal grains, and thus control the process as well as the heat treating and recrystallization which is essential to restore random arrangements of grains and the same properties in all directions. He discovers that cellulose, stretched rubber, silk, rayon, tendons, and muscle fibers are crystalline and finds that nature has a common building plan for all such complex substances, namely, long spiral molecule chains arranged in bundles whose size and arrangement as bricks in a chimney or as twigs in a brush-heap may be readily determined. He finds the patterns so sensitive that they specify the mine from which an asbestos sample has come, or the exact age of a growing cotton fiber, or the exact process by which a rayon thread has been manufactured.

He finds here a method of testing new ideas, of defining scientifically and exactly the conditions of manufacture which will assure uniform production of highest quality, and of demonstrating convincingly new patentable features of a process or product.

Possibly the greatest single advance recently in diffraction technic which is leading to even wider chemical and industrial use is in the design and construction of high-intensity X-ray tubes which permit an astonishing saving of exposure time. Hours and days have been required with the familiar old types of equipment for a photograph of adequate exposure.

Several new types of tubes have now been developed with which excellent patterns may be photographed in minutes or even seconds. Of these, an outstanding example is the Ott Selmayr tube developed at the University of Munich. No new principle of X-ray generation is involved, but merely a common-sense design which permits the maximum use of energy. Not only is a great saving of time and expense involved, but also the possibility of following chemical or physical changes in a specimen and of analyzing unstable substances which exist for only short periods of time. The experiment has actually been performed of mounting a bundle of cellulose fibers, photographing the diffraction pattern in one minute, moistening the bundle with alkali solution, and then making successive patterns every minute. The development of the mercerized structure shown by new interference maxima, and the disappearance of the original cellulose structure can thus be followed step by step. With such a high-intensity tube diffraction patterns may actually be seen on the fluorescent screen, and a rapid and exact method is thus afforded for determining the orientation of any single crystal, since of course the so-called Laue pattern of diffraction spots changes with the slightest movement of the crystal.

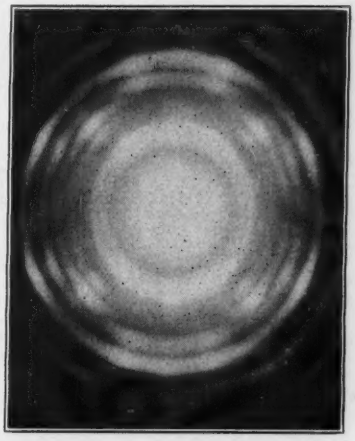


FIGURE 3.—DIFFRACTION PATTERN FOR COLD-ROLLED MOLYBDENUM RESISTOR RIBBON

Showing how cold work lines up crystal grains in definite orientation.

FIGURE 4.—PATTERN FOR GALVANIZED IRON NAIL

The structure of the steel wire from which the nail is constructed is indicated most strongly. The temperature of the galvanizing process has not been sufficient to cause recrystallization of the iron grains in random arrangement.

Some Practical Applications of X-Ray Diffraction Research

The following is a fragmentary list of actual examples of applications of the X-ray diffraction method to industrial problems. They are chosen to represent the wide scope.

FIGURE 5.—PATTERN FOR SHRED OF STEEL WOOL USED FOR CLEANING PURPOSES

A strong fiber structure is indicated.

1. Innumerable cases of structure, stability range, and predicted substitutes for alloys—brass, stainless steel, etc.

2. The mechanism of deformation in rolling mills and the effect upon structure, before and after annealing, of roll diameter; speed, raw material, type of mill, total reduction, reduction per pass, unidirectional or reversed passage through rolls, etc.; the effects of drawing, forging, cutting, hammering, stamping, torsion, etc.; a fundamental explanation and correlation of physical properties of metals such as tensile strength, ductility, hardness, reduction in area, etc. (Figures 3, 4, 5, 6A, 6B.)

3. The prediction and complete verification that sheet metal rolled under combined compression and tension with small rolls, so that the forces might be applied and balanced at the same place in the plastic metal, should be superior in structure, with fibering at a minimum, as compared with the usual method of rolling with large driven rolls.

4. Numerous determinations of proper heat treatment of metals. (Figures 7 and 8.) In one case the X-ray results showed that at the correct temperature of annealing of cast steel parts (also determined from a series of patterns) a better structure was obtained in thirty minutes than in the six hours previously employed.

5. A rational method of classifying forming steel and of predicting whether a given lot will form satisfactorily.

6. An exact method of control of heat treatment of electric silicon steel for minimum magnetic hysteresis loss and of actually classifying sheets as to magnetic behavior purely from the diffraction pattern, as well as a routine method of exact analysis of the amount of final cold work given a

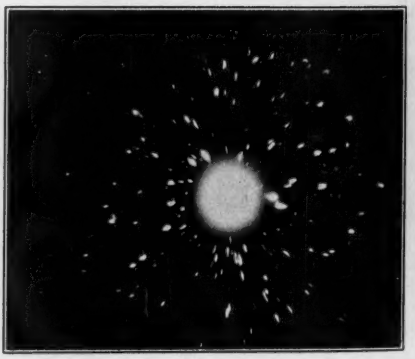


FIGURE 6A.—PATTERN FOR ARMCO IRON SHOWING LARGE GRAINS

sheet of metal after final annealing.

7. Proof of the zonal texture of wire and a control of proper dies and drawing conditions.

8. A proof of satisfactory welding operations on cylinders without undue fibering by plastic stretching.

9. Fundamental studies of age-hardening in duralumin (Figure 9), ingot iron, etc., causes, changes, and final effects.

10. The only rational method enabling study of effects of very small traces of impurities on properties of metals (for example, that 0.5 per cent iron in silver lowers the recrystallization temperature of the latter to room temperature and a trace of copper restores the value for the pure metal).

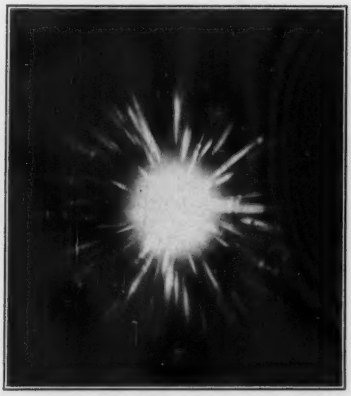


FIGURE 6B.—PATTERN SHOWING THE EFFECT OF HAMMERING THE SAME SPECIMEN

The radial streaks are indicative of distortion.

11. Discovery of unsuspected cases of new preferred orientation of grains after recrystallization where random arrangement is desired, as in silver, copper, and steel to explain peculiar behavior and failures, and grain size determination and specification in tungsten used for electric contact points.

FIGURE 7.—PATTERN FOR A SHEET OF BESSEMER STEEL MADE IN 1870

Showing good structure of fairly large grains and absence of preferred orientation and of distortion.

12. Analysis of cause of undue wear in spinning rings and control of case-hardening operations.

13. The selection and control of correct electrodeposition conditions for protective coatings by analyses of coating structures; nature of bonding of coating to base and whether a sudden or gradual transition (copper on steel, etc.); determination of proper structure and methods for maximum reflecting power of plated headlights.

14. Determination of causes of failure of galvanized coatings and a complete study of the structure of the entire transition zone between

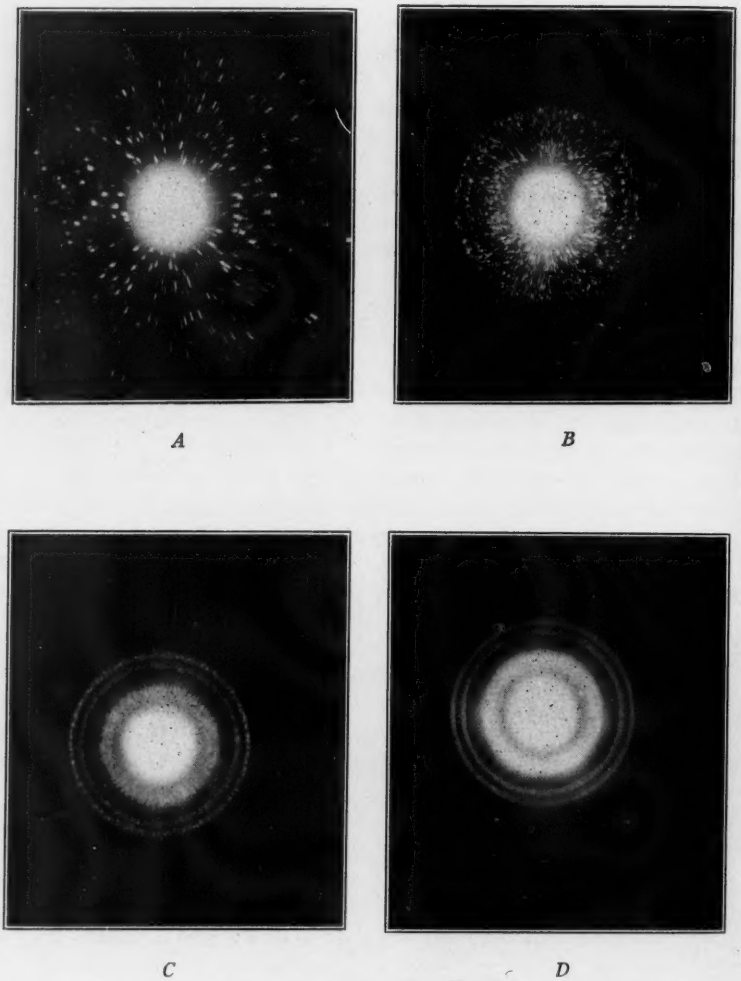


FIGURE 8.—*A*, *B*, *C*, AND *D*. FOUR PATTERNS OF LOW-CARBON STEEL

Showing how grain size determined by mechanical and heat treatment affects X-ray patterns. The grain size decreases from *A* to *D* which is characteristic of very small grains in random orientation.

steel base and outer pure zinc, and control of thickness of new non-equilibrium phase in which failure occurs.

15. Discovery of the cause of failure of patent leather by incipient true crystallization of soaps formed with the drier, leading directly to revised manufacturing methods and vastly improved product.

16. Study of the nature and structure of adhesives and control of proper molecular orientation, and measurement of molecular sizes and changes in linseed and china wood oils and test for complete solution of driers.

17. An improvement in the transparency of waxed paper from forty per cent that of air to over eighty per cent by a simple application of the diffraction results on influences affecting the crystallization of paraffin wax.

18. Numerous examples in catalysts for methyl alcohol production, electrodes, dentifrices, silicon carbide formation in furnaces (Figure 10), etc., of reactions and compounds formed which were deemed impossible at the temperatures or other conditions used.

19. A genuine improvement in the quality of rayon by showing the fundamental structural effect of every step in the process and by adapting these to produce the necessary ultimate structure (or diffraction pattern) essential for proper tensile strength, extensibility, gloss, etc. (Figure 11.)

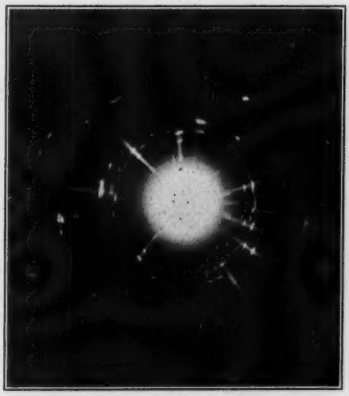


FIGURE 9.—TYPICAL PATTERN FOR ONE OF THE NEW ALUMINUM ALLOYS

Showing presence of both small and large grains and considerable distortion.

20. The first entirely scientific method of classifying cotton (Figure 12), silk, and wool fibers, and a clear presentation of the essential facts of wood structure which would enable proper treatment, improved behavior, and wider applications.

21. The only exact method of analysis of any material to prove whether or not it is true cellulose.

22. Comprehensive differentiation of cellulose nitrates and acetates in plastic films employed in photography films, control of composition, and proof that only the tri-esters are true crystalline compounds.

23. A method of specification for asbestos (single pattern) by comparison with standard patterns associated with practical behavior (Figure 13).

24. Determination of the mechanism of fireproofing fibers by absorption of solutions, and of the exact amount required (any excess

FIGURE 10.—DIFFRACTION PATTERN FOR SINGLE CRYSTAL FOR CARBORUNDUM FROM WHICH UNIQUE POSITIONS OF ATOMS OF CARBON AND SILICON IN SPACE MAY BE DETERMINED

producing its own diffraction effects).

25. Control of addition of dyes and other agents to rubber, and of the primary effects of various treatments on colloidal size; the only method of ascertaining true reproduction of natural rubber in synthetic rubbers.

26. Identification of chicle and control of synthetic and natural substitutes.

27. Identification of allotropic forms of gutta percha and balata.

28. Structural changes in ceramic materials of all kinds with given heat treatment.

29. Identification of chemical reactions and final constituents in enamels and glazes.

30. Control of burning of lime to assure freedom from carbonate and proper plasticity and of the dehydration of gypsum to plaster of Paris leading to re-use of plaster molds.

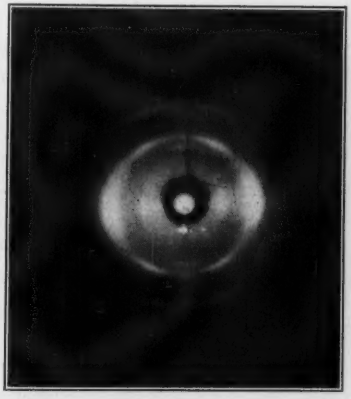


FIGURE 11.—PATTERN FOR IMPROVED VARIETY OF RAYON SHOWING FIBER STRUCTURE FROM THE LOCALIZED INTENSITY MAXIMA

The sharpness of these spots in contrast to the rings is a measure of degree of preferred orientation and of tensile strength.

31. Measurement of particle size in paint pigments, metals, etc., and control of production of carbon blacks.

FIGURE 12.—DIFFRACTION PATTERN FOR RAW COTTON

Showing characteristic cellulose structure and spiral construction of fiber.

32. Numerous cases of identification of essential substances extracted from natural products and foods and suggestions as to synthesis.

33. Structural proof for agents suitable as accelerators for the setting of concrete and a method for test of incipient devitrification of glass.

34. The demonstration that lubricating greases are crystalline and that proper orientation of long-chain molecules in layers is essential to lubrication, and the selection from X-ray crystal structure data of a dry white lubricant to replace graphite in lace-curtain factories.

35. Complete success in ascertaining difficulties in manufacture of soaps and method of specification for

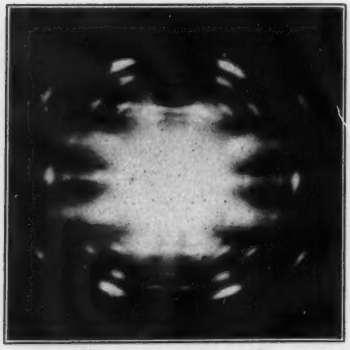


FIGURE 13.—TYPICAL PINHOLE PATTERN FOR NEARLY IDEAL FIBER, ASBESTOS

commercial oleic acid used as raw material.

36. Measurement of film thickness of every kind.

37. Analysis of fatty acids in cocoa butter.

38. Analysis and control of polymerization in synthetic resins and substitutes.

39. Studies on constitution and structure of boiler scale as a function of various conditions.

40. Analysis and method of selection of carbonado (black diamonds) employed as drills (Figure 14).

41. Studies of chemical and physical changes of substances adsorbed on charcoal or silica gel (for example, mercuric chloride solution adsorbed on carbon gives the pattern of mercurous chloride).

42. Determination of proper conditions for manufacture of best quality of ice cream, as to size and distribution of ice crystals.

43. Classification according to impurities and selection of proper manganese dioxide ores for use in electric batteries; identification of storage battery oxides.

44. Analysis of minute traces of metallic impurities in paper and parchment.

45. Classification and identification of precious and semi-precious stones and routine method of differentiation between fine and cultivated (containing mother-of-pearl center) pearls.

46. Classification of surgical catgut ligatures and sutures and effects of all chemical and digestional treatments; structural comparison of substitutes.

47. Classification of leather according to tanning, nature of chemical process, and in what form chromium, for example, is present.

48. Measurement and grading of thickness of leather (by method of X-ray absorption).

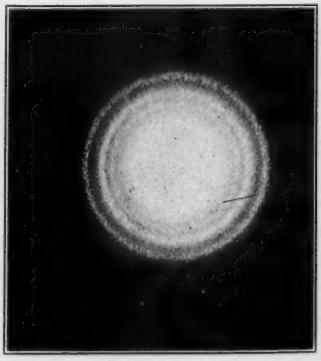


FIGURE 14.—PATTERN FOR BLACK DIAMOND OR CARBONADO

The diffraction rings are characteristic of ordinary diamond crystals in small fragments held together by a bonding material probably of amorphous carbon.

49. Proof of structural differences between normal and pathological tissues (cancer); and of tissues at rest and under tension.

50. Fundamental proof that colloidal materials such as cellulose, proteins of all kinds, chitin, etc., after being swollen by suitable agents and subjected to mechanical tension, have changed in perfecting directed orientation of colloidal micelles with improvement in tensile strength.

51. Characterization of synthetic drugs structurally in relation to natural and pharmacologically active products (ephedrine derivatives) and proof of influence of molecular sizes and symmetry.

52. Proof that crystallized insulin is pseudo-crystalline in the sense that no diffraction from planes occurs.

United States Civil-Service Examinations for Industrial Teachers. The United States Civil-Service Commission announces the following named open competitive examinations:

HEAD OF INDUSTRIAL TRAINING DEPARTMENT, $2900 a year, INSTRUCTOR OF SHOP SUBJECTS, SENIOR HIGH SCHOOL, $2300 a year, INSTRUCTOR OF SHOP SUBJECTS, JUNIOR HIGH SCHOOL, $2000 a year.

Applications for the above-named examinations must be on file with the United States Civil-Service Commission, Washington, D. C., not later than March 25, 1931.

The examinations are to fill vacancies in the Indian Field Service of the Department of the Interior.

Competitors will not be required to report for examination at any place, but will be rated on their education, training, and experience, and on a thesis or discussion.

Applicants for head of industrial training department must show at least two years' experience as a wage earner in trade or industrial occupations. In addition, they must show two years of successful experience in personnel management in industry, as vocational teacher, as instructor in an organized apprentice training program, or any combination of such experience.

Applicants for instructor of shop subjects, senior high school, must show that they have had at least two years of successful experience in teaching industrial arts; applicants for instructor of shop subjects, junior high school, must show one year of such experience. In addition, applicants for either position must show that they have completed at least two years' study in the teaching of industrial arts in a suitable institution, and a total of two years' experience as a wage earner in trade or industrial occupations.

Full information may be obtained from the United States Civil-Service Commission, Washington, D. C., or from the Secretary of the United States Civil-Service Board of Examiners at the post-office or customhouse in any city.

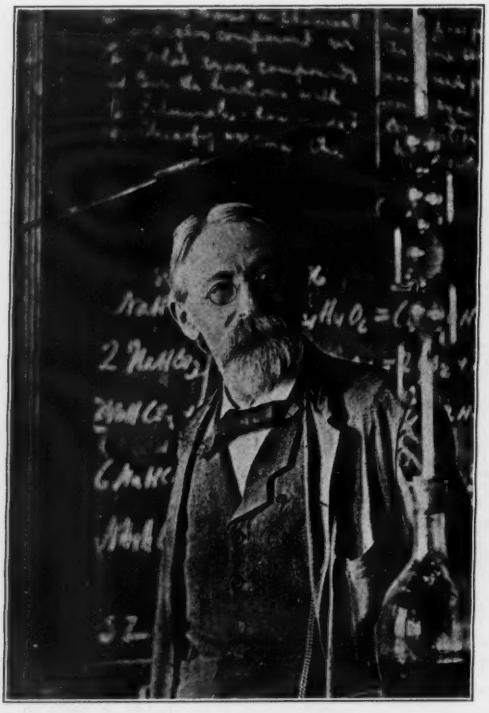
Student's Attitude Important to Success. Preparation, study habits, intelligence, and evaluative and persevering attitude—and the greatest of these is the attitude; these, Dr. M. E. Herriott, psychologist in the public schools in Los Angeles, California, calls the five major factors necessary for scholastic success. He discussed them in a recent report to the Western Psychological Association, deploring the fact that so little attention has been given by psychologists and educators to the attitudes of students.—*Science Service*

THE HISTORY OF THE DEPARTMENT OF CHEMISTRY OF THE OHIO STATE UNIVERSITY

WILLIAM MCPHERSON, THE OHIO STATE UNIVERSITY, COLUMBUS, OHIO

Editor's Foreword: *It is believed that a brief history of the departments of chemistry in our colleges and universities will be of interest not only to the chemists of today but also to the historians of the future. To afford the readers of the* JOURNAL *an opportunity to confirm or refute that belief, this article, written at the request of the editor of the* JOURNAL OF CHEMICAL EDUCATION *as the first of a tentatively projected series, includes a brief account of the development of the Department of Chemistry at The Ohio State University from the modest beginning of the department in 1873 with very simple facilities and with an enrolment of five students, to its present laboratory costing more than $1,000,000, amply equipped for three thousand students, and with an enrolment approximating that number.*

. . . . . .



SIDNEY A. NORTON

Professor of chemistry at The Ohio State University from 1873 to 1894.

The history of the Department of Chemistry of The Ohio State University begins in 1873 with the founding of the Ohio Agricultural and Mechanical College under the Morrill Land Grant Act of 1862. Ten departments, including that of chemistry, were authorized by the original Board of Trustees and from this modest beginning The Ohio State University has developed. Professor Sidney A. Norton was selected to initiate and to guide the new department. A graduate of Union College, Professor Norton had received thorough training in the classics as well as in the basic sciences. His wide interests are shown by the fact that in his younger days he was the author of successful

texts in English grammar, geology, physics, and chemistry. The last subject, however, became his special interest, and wishing to extend his studies in this field he spent some time in Germany, during which he studied chemistry at the Universities of Bonn, Leipzig, and Heidelberg. Upon his return he was elected professor of chemistry in the Miami Medical College of Cincinnati and retained this position until chosen professor of chemistry in the Ohio Agricultural and Mechanical College.

The newly organized college was housed in a single building and the Department of Chemistry was assigned an unpretentious set of rooms on the third floor of this building. The courses offered by Professor Norton, as published in the catalog of 1873-74, were as follows:

1. A *General Course* extending through one year consisting of an elementary study of inorganic chemistry, organic chemistry, and the application of chemistry to the arts.

2. A *Special Course* extending over three years composed mainly of qualitative analysis and quantitative analysis.

The college had a very modest beginning. About twenty-five students registered during the first year and of this number, five took the first-year course in General Chemistry. In the second year the attendance increased to fifty-nine. The Department of Chemistry shared in this increase, fourteen students being enrolled in one or the other of the different courses. In his report to the Board of Trustees, submitted in November, 1874, Professor Norton writes as follows:

> I believe that the majority of these are faithful students and hope that they will make good progress. I regret to add that the class is hampered by a few students who are not well prepared for the work. It is probable that some, if not all, of these ill-disciplined pupils will fail to pass their first examinations. We have two students in analytical chemistry, one of whom is ready to begin his course in quantitative analysis.

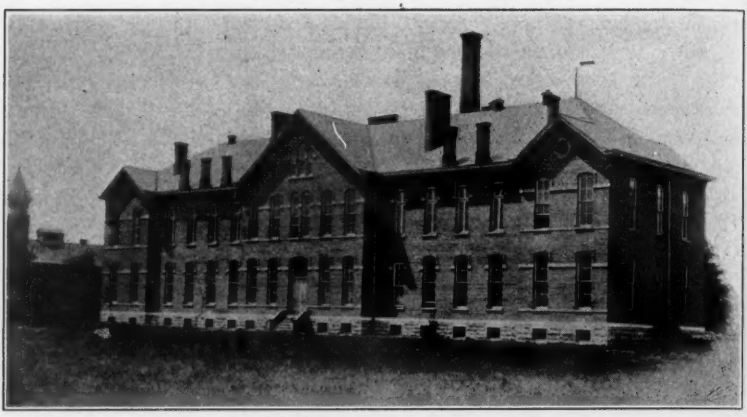
While the number of students was small they evidently took their work seriously, for in his report for 1875, Professor Norton writes:

> The students in analytical chemistry rather surpassed my expectations, doing more work than I had anticipated, and deserve praise for their accuracy and thoroughness.

He adds: "We need a small library for daily reference" and asks for $77 with which to purchase Watt's "Dictionary of Chemistry." This request was granted and due acknowledgment was made in his later report.

> At present the chemical library of the University consists of a Watt's Dictionary—a valuable book but not fully supplying our needs . . . We have begun to take a chemical journal.

The number of students gradually increased. In 1876 thirty-one students were enrolled in the department, in 1877, sixty-one, and in 1878,



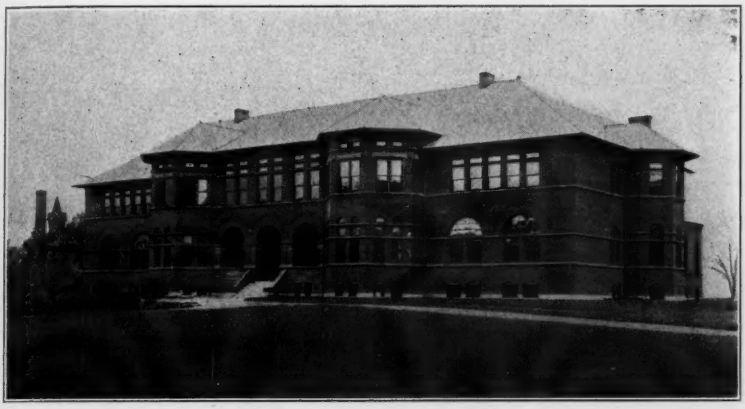
THE FIRST CHEMICAL LABORATORY
Built in 1882; destroyed by fire, 1889.

sixty-four, twenty-four of whom were taking laboratory work. Professor Norton writes in his annual report for 1876:

> Very many of the class in General Chemistry acquitted themselves with high credit, and the entire class is deserving praise for diligence and universal good behavior. The work done by the qualitative students is also commended, but I am not fully satisfied with the work accomplished by most of the quantitative students.

With an increasing number of students came the need of more commodious quarters and the General Assembly of 1881-82 appropriated $20,000 for the erection of a suitable laboratory. The structure was ready for occupancy in September, 1882. It consisted of a two-story building, the upper floor of which was assigned to general and applied chemistry and the lower to Mining and Metallurgy, together with the Department of Agricultural Chemistry which was yet to be established. Professor Norton in describing the new laboratory states that it is modeled after the great laboratory at Leipzig.

Because of new demands, the college began to assume more of the spirit of a university, and in 1878, after a lengthy discussion as to the real functions of the institution, the name Ohio Agricultural and Mechanical College was changed to The Ohio State University. A number of departments, some of them allied to the Department of Chemistry, were added. Included in this latter list were the following: the Department of Mining and Metallurgy, established in 1879 with Nathaniel W. Lord in charge; the Department of Agricultural Chemistry, established in 1884 with Henry Adam Weber as chairman; and the Department of Pharmacy authorized in 1885 with George B. Kauffman in charge.



THE SECOND CHEMICAL LABORATORY
Erected in 1899; destroyed by fire, 1904.

Unfortunately, the sum appropriated for the erection of the laboratory was not sufficient to make the building fireproof, and on the morning of February 12, 1889, the entire laboratory was destroyed by fire. The General Assembly then in session promptly appropriated $40,000 for a new building. Temporary quarters for the Department of Chemistry were provided in University Hall and the new building, pushed to completion, was occupied in September, 1890.

The methods of teaching used by Professor Norton followed closely those used in Germany. The first-year course consisted of lectures on inorganic chemistry and these were followed during the last third of the year by lectures on organic chemistry. The second year was devoted to qualitative analysis and the third to quantitative analysis. A student of Bunsen, Professor Norton laid great stress on "reactions in the dry way"; also on the "use of the blow-pipe in determinative mineralogy." Many of his older students will recall the course in qualitative analysis which ran as follows:

First term: Reactions in the dry way and determination of 25 unknowns.
Second term: Reactions in the wet way.
Third term: Same continued; 75 unknowns.

Upon the completion of the laboratory, new courses were offered in stoichiometry, toxicology, and proximate organic analysis, the three constituting an additional year's course.

During the first few years Professor Norton had no help, except from certain of his students who counted it a great privilege, without any compensation whatever, to assist him, especially in the preparation of his

experiments. In 1879, however, Mr. David O'Brine, then a student in the department, was employed as student assistant. Following Mr. O'Brine's resignation in 1887, Mr. Frederick Keffer, a member of the class of '82, was elected to take his place. Upon his resignation in 1892, Mr. William McPherson, a member of the class of '87, was chosen to fill the vacant position.

Professor Norton, trained in the methods of the German universities, believed that the first-year course in chemistry should consist of lectures and examinations, unaccompanied by laboratory practice. Other members of the instructional staff of the university, interested in the development of the method of teaching chemistry, insisted that laboratory work was just as essential a part of the course in general chemistry as it was of the course in qualitative analysis. The feeling became so intense that Professor Weber finally withdrew all first-year students in agriculture from the Department of Chemistry and provided for them a separate course in the Department of Agricultural Chemistry, in which laboratory work was made an essential part. This action was followed by the withdrawal from the Department of General Chemistry of all the freshman engineering students and their assignment to the newly created course in the Department of Agricultural Chemistry. This step led Professor Norton, against his better judgment, to the introduction of a limited amount of laboratory work in the first-year course.

In 1894, Professor Norton, on account of his advancing age, was made lecturer in general chemistry and Mr. McPherson was placed in charge of the department, with the title of associate professor. Steps were taken immediately to make laboratory work an essential part of the first-year course. As a result, the freshmen in agricultural chemistry and in engineering were transferred back to the Department of General Chemistry.

The introduction of laboratory work as an essential part of the course, together with the augmented number of students, necessitated additions to the instructional staff. Accordingly, in 1894, the Board of Trustees appropriated the sum of $600 for two new members to be known as "fellows and laboratory assistants." Mr. William L. Evans, the present chairman of the department, and Mr. Raymond M. Hughes, the present president of Iowa State College, were elected to these positions and assumed charge of the laboratory work in connection with the first-year course.

The rapidly increasing numbers soon made further assistance necessary so that in 1896 Mr. Charles W. Foulk, a member of the class of 1894, and, at the time, private assistant to Professor Nathaniel W. Lord, was elected assistant, and to him was assigned the work in analytical chemistry. One year later Mr. McPherson was promoted to a full professorship in charge of the department. These changes made it possible to offer new courses in inorganic preparations, electrolytic analysis, and in

THE THIRD CHEMICAL LABORATORY

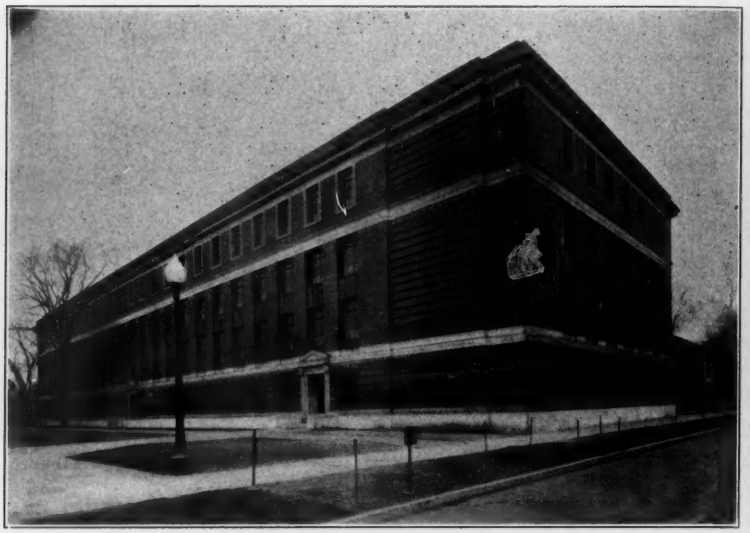
Erected in 1906; vacated by the department of chemistry in 1926 and converted into a Hall of Languages.

sanitary and applied chemistry. There was also adopted a four-year curriculum leading to the degree of bachelor of science in chemistry.

In June, 1899, Mr. Foulk was granted a leave of absence and spent two years as a student of Ostwald at the University of Leipzig. Mr. William E. Henderson, a graduate of The Johns Hopkins University, and then professor of chemistry at Ohio University at Athens, was elected to carry on the work during Mr. Foulk's absence. During this period a new course was added in historical chemistry and the work in physical chemistry was extended.

The department grew in numbers so rapidly that on Mr. Foulk's return in 1901 to resume his duties, Mr. Henderson was retained as a permanent member of the staff, both Mr. Foulk and Mr. Henderson having the title "assistant professor of chemistry." This addition to the staff made possible new courses in organic chemistry, rare elements, and the teaching of chemistry, as well as a four-year curriculum leading to the degree of B.Sc. in chemical engineering.

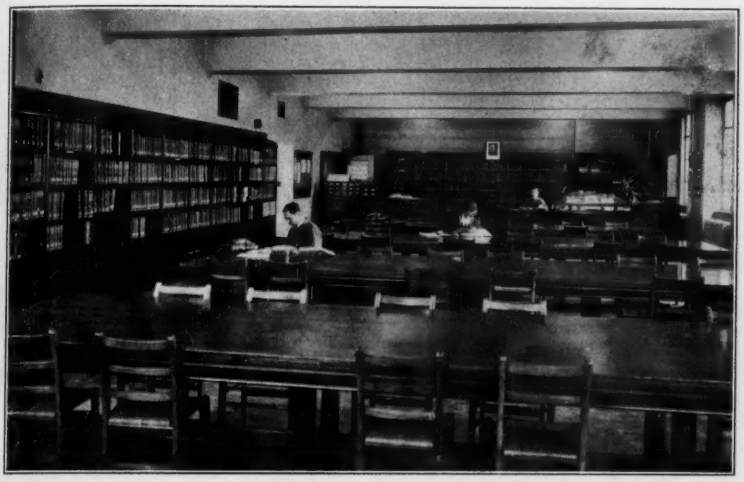
The General Assembly in 1902 appropriated $20,000 for an addition to the laboratory. This had been occupied only a few months when, on the evening of February 19, 1904, the entire laboratory burned to the ground. The General Assembly then in session promptly voted an appropriation of $15,000 for temporary equipment, as well as an appropriation of $100,000 for a new laboratory. Plans were rapidly formulated and the new laboratory was occupied at the opening of the academic year 1906-07.



THE PRESENT CHEMICAL LABORATORY
Completed in 1929.

The first-year class in general chemistry continued to grow in numbers to such an extent that it was found necessary to employ additional assistants. Consequently in 1905, Mr. William L. Evans, a former assistant in the department and later a graduate of The University of Chicago, was elected assistant professor of chemistry and given charge of the first-year work. One year later, Mr. James R. Withrow, a graduate of the University of Pennsylvania, was elected a member of the staff and placed in charge of the industrial chemistry. Under his guidance the number of students interested in industrial chemistry grew to such an extent that in 1924 a separate Department of Chemical Engineering was established with Mr. Withrow as chairman. In 1907 Mr. Cecil E. Boord, a graduate of Wabash College, was elected fellow in the department. Subsequently upon receiving his doctor's degree, he was promoted through the various ranks until in 1924 he was made professor in the division of organic chemistry.

It was inevitable that the work of the department should have been hampered somewhat during the great war. Mr. McPherson and Mr. Evans were absent on war duties during the entire period. The other members of the instructional staff of the department, and especially Mr. Henderson, Mr. Boord, and Mr. Withrow, not only assumed the extra burdens of teaching but also spent much of their time on war duties. Mr. Marion Hollingsworth (Ph.D., The Ohio State University) and Mr. Jesse Erwin



THE CHARLES CUTLER SHARP LIBRARY OF THE DEPARTMENT OF CHEMISTRY

Day (Ph.D., The Ohio State University) were added to the instructional staff during this period with the rank of instructor, and their promotion has gradually followed.

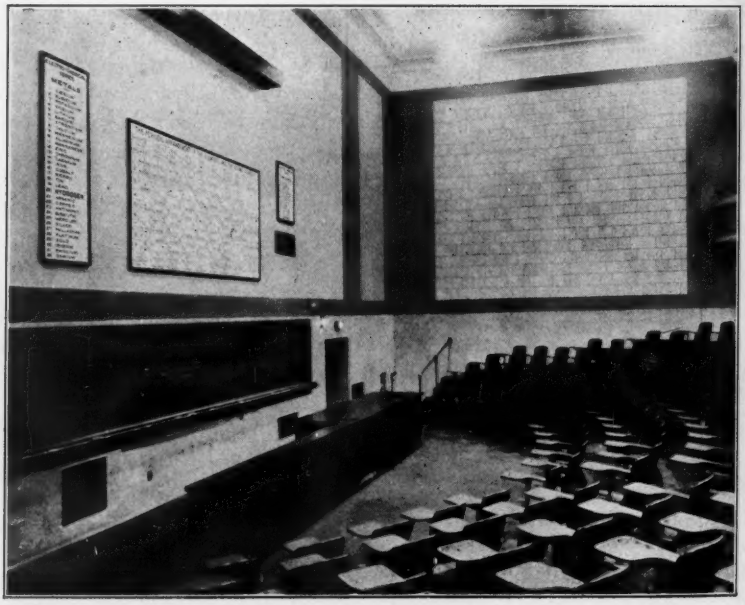
During this interval, the growth of interest in physical chemistry and in colloid chemistry made further additions to the staff necessary and in 1919 Mr. Edward Mack, Jr. (Ph.D., Princeton University), was placed in charge of the division of physical chemistry. In the next year Mr. Wesley G. France (Ph.D., University of Michigan) was chosen to head the division of colloid chemistry. More recent additions to the instructional staff include the following: Mr. Wallace Brode (Ph.D., University of Illinois), Mr. Herrick L. Johnston (Ph.D., University of California), Mr. Harry V. Moyer (Ph.D., University of Kansas), Mr. W. Conard Fernelius (Ph.D., Stanford University), Mr. Melville L. Wolfrom (Ph.D., Northwestern University), and Mr. G. Bryant Bachman (Ph.D., Yale University).

In 1921 Mr. Henderson was elected dean of the College of Liberal Arts. He retained this position until 1927, when increasing duties in connection with the headship of the division of inorganic chemistry made it necessary for him to resign the deanship.

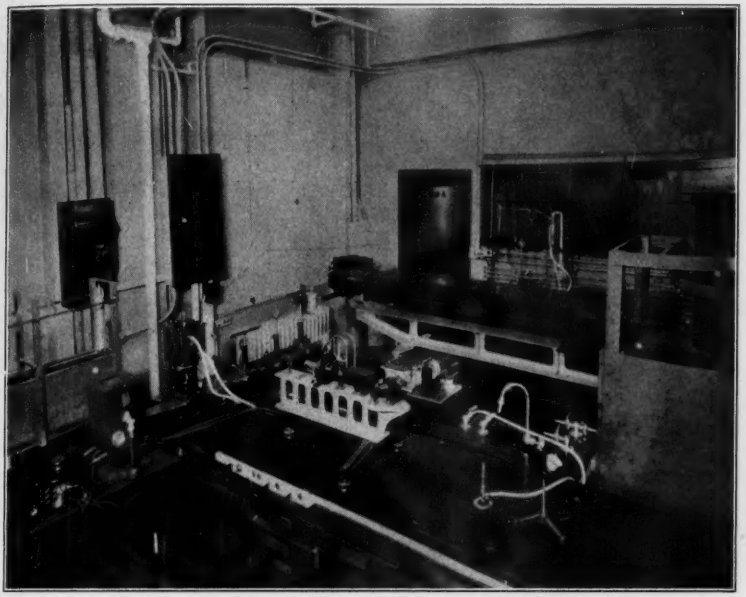
The laboratory constructed in 1906-07 proved insufficient to accommodate the large number of students and a new laboratory was authorized by the General Assembly. The first section of this building was built in 1924. Other sections followed in succeeding years until the building was entirely completed and occupied in 1929. The cost of the entire

VIEW IN ONE OF THE FRESHMAN LABORATORIES

building was $1,062,632. It consists of two main parts, namely: (1) a four-story front 308′ × 80′, and (2) attached to the rear of this, a one-story building of shop construction, 300′ × 206′. The laboratory provides ample accommodations for about 3000 students and is adequately equipped with all the apparatus required both for instruction and for research in the field of chemistry. A professional glass-blower and also an expert machinist constitute a part of the staff. The library has



LECTURE ROOM



ONE OF THE RESEARCH LABORATORIES

been generously endowed by Mr. Charles Cutler Sharp, a graduate of the university of the class of '88.*

From the standpoint of teaching, one of the most difficult problems with which the department has had to deal, has been that of finding satisfactory methods for the instruction of the large class in elementary chemistry numbering, during the present year, more than 1500 students. In the earlier years of the department when the class was comparatively small, and the teaching of chemistry in our high schools was distinctly inferior in quality, all first-year students were combined in a single class, thus completely ignoring any previous training that the student might have had in the subject. Later, with increasing numbers, and with a very marked improvement in the quality of high-school chemistry, the class has been divided into two main sections; those who have had a year's course in high-school chemistry being placed in one section, and those who have had no previous training in the subject, in the other section. The former section is given a decidedly more advanced course and is differentiated in other ways from the latter (*2*). For the first time, during the present year, a third section was formed. At the beginning of the year, during "Freshman

* A detailed description of the building may be found by consulting reference (*1*).

THE CHIEF MEMBERS OF THE PRESENT INSTRUCTIONAL STAFF OF THE DEPARTMENT OF CHEMISTRY

Front row (left to right): EDWARD MACK, JR., CECIL E. BOORD, WM. MCPHERSON, WM. L. EVANS, WM. E. HENDERSON, C. W. FOULK, JESSE E. DAY, WESLEY G. FRANCE.
Back row (left to right): MELVILLE L. WOLFROM, G. BRYANT BACHMAN, MARION HOLLINGSWORTH, W. CONARD FERNELIUS, HERRICK L. JOHNSTON, HARVEY V. MOYER, WALLACE R. BRODE.

Week," a preliminary test was given to all students who had had a preliminary course in chemistry and who expected to continue the study. Those who made a high grade in this test were placed in this new section with the expectation that they would complete the course in two quarters, thus saving one quarter to be devoted either to a more advanced course in

chemistry or to some other subject. This experiment promises to be a success.

The Graduate School of the University was organized in 1911, and Mr. McPherson was elected to the deanship. The department immediately began to place additional stress upon graduate work. Scholarships, fellowships, and part-time assistantships were created and the number of graduate students gradually increased. Approximately 100 graduate students are now enrolled in the department, and up to the present time, the university has conferred the degree of doctor of philosophy upon 148 students majoring in some field of chemistry.

At present the research activities of the department are concentrated on the following studies: (1) carbohydrates, their synthesis and reactions; (2) the mechanism of the Grignard reaction; (3) the synthesis and structure of the organo-titanium compounds; (4) the relation between optical rotation, absorption spectra, and chemical constitution; (5) the chemistry of synthetic medicinals and the higher acetylenes; (6) the priming and foaming of boiler feed water; (7) decomposition of gaseous metallic alkyls; (8) determination of the sizes and shapes of molecules; (9) application of thermodynamics and quantum theory to chemistry; (10) the chemistry of bacteria; (11) the catalytic combustion of carbon; (12) reactions in liquid ammonia; (13) polythionic acids and their salts; (14) stability of suspensoid sols.

Mr. McPherson continued to act both as chairman of the Department of Chemistry and dean of the Graduate School until 1928, when the growth of these two activities made it no longer possible for one person to fill both positions; accordingly, he resigned the chairmanship of the department and Mr. Evans, whose researches in the field of carbohydrates brought to him, in 1929, the award of the Nichols Medal, was elected to the position thus made vacant. The present organization of the department is as follows:

WILLIAM L. EVANS, *chairman*

Division of General Chemistry	WILLIAM L. EVANS, *head* JESSE E. DAY, *acting head*
Division of Analytical Chemistry	CHARLES W. FOULK, *head*
Division of Inorganic Chemistry	WILLIAM E. HENDERSON, *head*
Division of Organic Chemistry	CECIL E. BOORD, *head*
Division of Physical Chemistry	EDWARD MACK, JR., *head*
Division of Colloid and Electrochemistry	WESLEY G. FRANCE, *head*

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(1) DAY and BURD, *The Hexagon of Alpha Chi Sigma*, **21**, 199–201 (Jan., 1931).

(2) EVANS and DAY, "An Experiment in Coöperative Teaching," J. CHEM. EDUC., **5**, 1133–5 (Sept., 1928).

ENZYMES AND VITAMINS IN PRESENT-DAY CHEMISTRY*

H. C. Sherman, Columbia University, New York City

Enzymes and vitamins are of very broad scientific significance in that they catalyze and control the chemical processes upon which life depends. Their chemical natures are, therefore, being studied very actively. Some of the outstanding features of the methods and results of such investigation are summarized here.

. . . . . .

It was one of the most contentious but not one of the most profound or constructive philosophers who said, "If you wish to converse with me you must first define your terms."

May I, then, begin not with a definition of present-day chemistry but with a disclaimer of any special interest in such definitions? It is well to remember that all divisions of science into sciences with resulting definitions and so-called boundaries are merely man-made: nature recognizes no such grounds for separation!

Specifically, there are, and can be, no real boundaries or dividing lines between chemistry, physics, and physiology: each overlaps both of the others.

We are interested in chemistry, perhaps from a professional point of view; certainly from the point of view of scientific research. It has been said that the chief objective of all such research is *to render intelligible the world in which we live.*

It would seem then that among the most fundamental and far-reaching services which chemical research can render to scientific progress are its contributions, first, to a better understanding of the *structure of matter,* and second, to a better understanding of the *processes of life.*

In the first, we have learned that it is futile to attempt to draw a line between what is chemistry and what is physics; in the second, we are now learning that it is equally futile to attempt to draw any sharp line between chemical and physiological research.

Chemistry is equally chemistry whether studied *in vitro* or *in vivo.* In both cases it is impossible to divorce it from its cognate sciences; nor would we desire to do this if we could. The interpenetration of chemistry and physics has been consciously cultivated for a generation at least and is now a matter of course from the most elementary of chemistry teaching onward; and present-day chemistry is now (somewhat slowly, it is true) coming to realize that it has a birthright also in the better understanding of life, to be realized by the broadening of chemistry on its physiological side, as it has already broadened on its physical side with such epoch-making results during the past generation or two.

* Presented to the graduate seminar in chemistry at Yale University, October 22, 1930.

At the Richmond meeting of the American Chemical Society, Dr. Vaughan contributed a paper which he called "A Chemical Conception of the Origin and Development of Life" (perhaps a biologist would call it *too* chemical a conception!). There is not time in this talk to attempt to set forth Vaughan's conception as a whole but it was notable, among other things, for the emphasis laid upon the fact that, chemically, there is no demonstrable gap between living and non-living matter—the protoplasmic proteins of the living cell, the filtrable viruses, some of the substances concerned in immunity, some (at least) of the enzymes, and some of the native proteins which have been purified and investigated as chemical entities, merging into each other by indistinguishably minute differences so far as their chemical nature is concerned—and the added fact that, broadly viewed, the distinguishing feature of living matter is that it "trades in energy"—its chemical processes are in some way activated; the living matter is not simply a passive beneficiary of, but rather is an active agent in, the chemical processes upon which life (as we know it) depends.

Starting, then, with Dr. Vaughan's effective phrase, "Living matter trades in energy," let us ask, Whence the energy? and How the "trading?" *i. e.*, the activation of the energy-transforming process?

While we have long known that our source of energy is the sun, we still have but fragmentary knowledge as to how and to what extent our bodies can (aside from warmth) make use of the radiant energy of sunshine *directly*. One of the most interesting of recent scientific discoveries is that certain wave-lengths bring about the formation of vitamin D in the skin. Doubtless there are other ways in which radiant energy is directly utilized by the body; but it is well established that by far the greatest part (probably well over ninety-nine per cent) of the energy transformed in the body and used in the support of its life processes—the energy which its living matter "trades in"—is derived from the oxidation of organic foodstuffs, the cleavage products of the carbohydrates, fats, and proteins.

And your own Professor Henderson has shown that when the rate of energy transformation in the body is very greatly increased, as during the strenuous exertion of a boat-race ("the maximum of human power" was, I think, his phrase to describe the Yale crew in action), it is these same substances which are oxidized, and in about the same quantitative relations to each other.

But how is the rate of cleavage and oxidation of carbohydrates, fats, and proteins in the body made to run so much faster than at the same concentration, temperature, and hydrogen-ion activity *in vitro?*

These processes must be very highly catalyzed by something (or some things) in the living matter, or formed by it.

What then of the chemical nature of these catalysts?

Hopkins has shown that at the actual site of oxidation the process is catalyzed (probably not exclusively) by the oxidation-reduction catalyst, *glutathione*. This is a compound of glycine, glutamic acid, and cysteine.

Another oxidation catalyst, *thyroxine*, is brought to the tissues from the thyroid gland. From its structure as established by Harington it appears to be a derivative of tyrosine.

Sometimes still another speeder-up of the transformation process comes into play in the form of *adrenine*, *adrenaline*, or *epinephrine*, which also is probably a derivative of tyrosine.

Insulin, which probably catalyzes some change preceding the actual oxidation, appears to be still another amino acid derivative, more complex than any of those just mentioned but less complex than typical proteins.

The hydrolytic enzymes catalyze earlier cleavages in this same chain of coördinated transformations by which the stored energy of the foodstuffs is brought rapidly into the life process; and these enzymes also, in the cases which have been most fully investigated, appear to be amino acid derivatives, probably of higher molecular weight than insulin and approaching or resembling the typical proteins in chemical complexity.

Investigation of the chemical nature of enzymes has proved exceedingly difficult. In fact it is difficult even to state the results of such investigation in terms at once concise enough to be clear and full enough to be convincing. Until recently enzymes were known only in the colloidal state, and so accustomed have chemists become to leaning upon the physical properties of substances in their work that in the study of enzymes they have felt serious embarrassment if not actually a sort of estrangement in the fact that here they could not rest identification upon physical properties but must depend upon purely chemical criteria. The characteristic property of every enzyme is its catalytic effect upon some chemical process—its so-called enzymic activity.

The existence of such substances as we now call enzymes first became known through the observation that barley malt had the property of hydrolyzing starch. Since this must have been due to something previously unknown but contained in the malt, a concentration of this obscure substance was later sought by fractioning the malt in different ways, testing the fractions, rejecting those which did not show the peculiar property, and fractioning still further those in which it appeared.

The principle is well illustrated in the now classical investigations which led to the isolation of radium.

Uranium and thorium were known to be radioactive when Madame Curie discovered that two minerals, pitchblende and chalcosite, showed greater radioactivity than pure thorium or uranium, suggesting the presence in these minerals of some new element more radioactive than any

of the elements previously known. The Curies then set to work to separate pitchblende into its constituents, much as they would have begun a complete chemical analysis of any mineral, but with the added feature that after each separation or fractionation all the products were examined for radioactivity, not only qualitatively but quantitatively, by means of the electroscope. In this way they could not only follow the fate of the radioactive material but also could judge of the *extent* to which they were succeeding in concentrating it. Also, at each step, the fraction which showed the radioactivity was examined spectroscopically and it was only when they had concentrated the radioactivity fifty-fold that they were first able to see new lines in the spectrum, indicating the presence of a new element. Further fractionation, guided still by measurements of radioactivity to show the concentration of the radioactive material, brought them finally to the attainment of a constant maximum radioactivity which meant the isolation of radium in the form of a pure salt. (For the sake of brevity we must omit description of the isolation of radioactive actinium and polonium from other fractions of the pitchblende.)

Now the process of purifying a natural enzyme, or separating it from the other substances with which it is mixed in the plant or animal tissue or secretion in which it is found, is similar in principle to that by which radium was isolated from pitchblende. Just as the isolation of the radium was best guided and judged by quantitative measurements of its characteristic property of radioactivity, so the isolation of the enzyme is best guided and judged by quantitative measurements of its characteristic enzymic activity.

Attempts to isolate an enzyme, by fractioning the natural material which contains it and continuing the fractionation until the characteristic property is concentrated to a constant maximum by removal of all other substances, involve very great difficulties.

First of all, the enzyme itself is apt to be undergoing disintegration during the process. Another difficulty is that the fractionation may remove something which, while itself having no enzymic activity, is helpful, or possibly even essential, to the full activity of the enzyme, so that, if tested without sufficient regard to this possibility, an enzyme after purification may be purer in the sense that the product is more nearly a single chemical individual and yet may show less of the characteristic enzymic activity than before. This difficulty has had the very unfortunate effect of leading many students of the question, and even some prominent investigators, to minimize or neglect the importance of the measurement of activity as a guide both in the development of methods and in the interpretation of results of research upon the purification of enzymes.

Since the enzymic activity is the essential characteristic of every enzyme, any failure to make the fullest use of quantitative measurements of activity in enzyme research must seriously restrict its value.

Undoubtedly the best method of meeting this difficulty is to work out experimentally, separately, and quantitatively for each enzyme to be investigated, a knowledge of all the environmental conditions such as the hydrogen-ion activity (pH) and the optimum concentrations of such other ions as may be essential to the best activity of the enzyme, as well as the best conditions of time, temperature, and kind and concentration of substrate to be used in the quantitative measurements of the activity of the enzyme preparation.

When through long and systematic experimentation one has acquired a sufficiently complete and accurate knowledge of the environmental conditions required, first, to conserve the enzyme as well as possible from deterioration during investigation, and second, to permit of its exerting the full catalytic effect of which it is capable in the quantitative determination of enzymic activity, then only is one in position to attempt the isolation of an enzyme from the material which contains it in nature according to the same scientific plan of procedure as was followed in the isolation of radium from pitchblende. Working according to this general plan, the late Dr. T. B. Osborne purified malt amylase and reported it to be of protein nature. We have confirmed his conclusion and extended the study to the investigation of pancreatic amylase which has yielded results of the greatest interest from the point of view of quantitative research.

Employing several different combinations and modifications of the processes of extraction, adsorption, dialysis, and fractional precipitation, workers in our laboratory repeatedly have obtained preparations of purified pancreatic amylase of apparently uniform chemical and physical properties and of practically constant maximum enzymic activity; and this product, like the malt amylase previously prepared by Osborne, is of protein nature. Inasmuch as the varied fractional precipitations to which this product was subjected would presumably have changed its composition and properties if it had contained any large admixture of materials, the fact that the enzymic activity showed quantitative constancy at the maximum is strong direct evidence of the protein nature of the enzyme.

In 30 minutes at 40°, this material splits about 20,000 times its weight of starch and forms about 10,000 times its weight of maltose. Although subject to serious deterioration in solution, the activity of this material is such that when tested in longer experiments it digested 4,000,000 times its weight of starch and formed no less than 2,800,000 times its weight of maltose before it had all become inactivated.

This marked enzymic activity was exhibited by the preparation at a dilution of 1:100,000,000 parts of water. The most delicate tests for proteins are not valid at dilutions greater than about 1:100,000. The material when tested in concentrated form reacted like typical protein to the usual protein tests, but its own enzymic activity constituted a test

for its presence which was 1000 times (1000-fold) more delicate. Thus the failure of protein reactions in solutions enzymically active does not necessarily show that the enzyme is of other than protein nature in its chemical composition, although this negative conclusion has been erroneously drawn by some investigators and is repeated by many writers.

Here it is of interest to recall the experience of the Curies in the concentration of radium from pitchblende as already mentioned. It was only after they had intensified the property of radioactivity fifty-fold by concentration of the radioactive element that its presence was revealed analytically even by so delicate a test as the use of the spectroscope. Delicate as is the spectroscopic test, the property of radioactivity constituted a test at least fifty times more delicate. When now in our work with pancreatic amylase we find in an analogous way that the property of enzymic activity is a test for this enzyme which is 1000 times more delicate than any analytical test for the protein of which the enzyme preparation is materially composed, we see how easy it can be for an investigator to be misled as to the chemical nature of an enzyme by obtaining something which shows enzymic activity, but does not respond to analytical tests for protein.

In addition to quantitative elementary analyses and qualitative reactions in all of which our pancreatic and malt amylase preparations show results typical of protein substances, we have submitted both of these enzyme preparations to quantitative analysis with reference to the eight forms of nitrogen determinable by the Van Slyke method with results which show that the enzyme preparations yield all these products of hydrolysis in proportions within the range of variation shown by such typical protein materials as casein, edestin, hair, and hemoglobin.

This view of the chemical nature of the enzyme is supported by evidence of other kinds which, while indirect, is none the less instructive. For example:

The investigations upon pancreatic amylase have shown that this enzyme loses its activity in aqueous solutions as already mentioned, that this loss proceeds more rapidly with increase of temperature, and that it is undoubtedly connected with hydrolytic changes taking place in protein material which constitutes either the enzyme molecule itself or an essential part of it. Extensive quantitative studies of the conditions influencing the rate of hydrolytic inactivations of the enzyme, especially as affected by added amino acids, gave new evidence of its protein nature.

This was further confirmed by the quantitative finding that the antiseptics which act chemically upon proteins are enormously more destructive of the enzyme than are the antiseptics of the lipoid-dissolving type.

The amylase of malt has yielded similar results: and it has also been possible in working with this more stable enzyme to demonstrate that it

has a definite iso-electric point or zone and that the material which shows the enzymic activity is an ampholyte, presumably protein. Certainly it is quite improbable that, if the enzyme were a substance of some other chemical nature, it would be so inseparable from the particular protein with which associated as to migrate with it under the influence of the electric current in either direction according to the hydrogen-ion concentration (or activity) of the solution.

Thus experimental evidence of at least four kinds all points clearly and consistently to the protein nature of the enzyme. Largely because of its quantitative character, the evidence is more convincing the more fully and critically it is studied.

Thus far this discussion has been centered upon the starch-splitting enzymes for a combination of reasons: they are the ones which my own experience best fits me to discuss; they have a double claim to a sort of primacy in being the first type of enzyme discovered and in having to do with that source of energy (starch) which is quantitatively the most important of the reserve stores of fuel for the support of life processes, *i. e.*, for chemistry *in vivo;* and, last but not least, I desired to do honor to the late Dr. Osborne whose work in the purification of one of these enzymes as early as thirty-five years ago was a model of painstaking scientific investigation for its time and marked an extremely important advance all too often overlooked by subsequent experimenters and writers.

Undoubtedly the most widely accredited criterion of chemical homogeneity is the ordered spatial arrangement of the crystalline state. Hence the preparation of purified enzyme in crystalline form has been an important desideratum in the study of the chemical nature of these substances. This has recently been accomplished.

It was in 1926 that Sumner reported the crystallization of urease. He described his preparation as "a new protein which crystallizes beautifully and whose solutions possess to an extraordinary degree the ability to decompose urea into ammonium carbonate." The urease also underwent gradual inactivation in water solution, and amino acids tend to preserve the enzyme here as had been found by previous workers in the case of amylase.

Northrup (1929, 1930) has described "a crystalline protein from commercial pepsin preparations which has powerful peptic activity. The composition, optical activity, and proteolytic activity of this protein remain constant through seven successive crystallizations. No evidence for the presence of a mixture or a solid solution is found in a study of the solubility of the protein in a series of different salt solutions, or from the diffusion coefficient, or from the rate of inactivation. These results indicate that the material is a pure substance or possibly a solid solution of two or more substances having nearly the same solubility in all the various solvents

studied. It seems reasonable to conclude from these experiments that the possibility of a mixture must be limited to a mixture of proteins, so that the conclusion seems justified that pepsin itself is a protein."

Still more recently Caldwell and Booher, continuing the research upon pancreatic amylase above-mentioned, have obtained from highly purified preparations of this amylase a crystalline substance organic in nature and possessing in remarkable degree the properties of this amylase. Professor P. F. Kerr has kindly examined the product and describes it as consisting of isotropic elongated crystals which exhibit slight double refraction and a refractive index of 1.54. The crystals appear to be of the same protein nature as the amorphous purified pancreatic amylase from which they are obtained, and like it have shown high enzymic activity.

Unless there should develop some desire to be unprecedentedly meticulous, the protein nature of these best-studied and presumably representative enzymes may now be regarded as established; and, in view of the enormous importance of enzymes in the chemistry of life, it would seem that the proteins have acquired new justification for the arrogance of their name.

It is, of course, to be kept in mind that in speaking of the protein nature of enzymes we refer only to their ultimate and proximate composition or chemical make-up. Obviously they differ from ordinary proteins, for they have catalytic properties which ordinary proteins have not. Hypotheses as to possible unstable or highly labile linkages within or between some of the amino acid radicles of the enzyme molecule to which the catalytic effects may be referred are still too tentative for discussion in such a brief summary as this. Hence our present knowledge of the chemical nature of typical enzymes may be said to explain their "Whence?" but not their "How?"

In only a few cases has the study of the chemical nature of the vitamins yet reached a corresponding stage; but already an extremely important chapter has been added to chemistry through vitamin research.

From the point of view that scientific research seeks to render intelligible the world in which we live, plainly one of its fundamental questions must be, What substances does the living organism require from its environment?

It was the broadening of chemistry toward physiology which accustomed chemists to the use of experimental animals as reagents and instruments of research and thus rendered possible the discovery of a whole group of essential substances whose existence up to a few years ago had been either entirely unknown or only very vaguely apprehended. These are now known as *the vitamins*, being thus grouped together not because of chemical relationship but because the demonstrations of their respective existence and importance have followed each other too rapidly for chemical isolation

and structural identification to keep pace. Hence substances which probably are no more alike in their chemical natures than are, for example, cholesterol and tryptophan, are for the present included under the one group name.

The immediate significance of the discovery of vitamins was to make possible for the first time the formulation of a scientifically sound conception as to what chemical factors enter, from without the organism, into the life process.

From being thus able to give, even if not yet quite explicitly, a qualitative definition of the adequate in nutrition, chemical research has promptly pressed forward toward the quantitative determination of the optimal.

At first glance this might appear as simply another manifestation of the general tendency of present-day science to develop its quantitative aspects—to hold itself rigorously to the task of becoming constantly a more and more exact science. But this goes deeper than that.

For we are finding that a food supply which is already adequate may be so improved by enrichment in certain of its chemical factors that the already normal life process is measurably bettered.

The individual results are still within the range of the normal; but the average status of the life process is improved at all stages of the life cycle: many young lives are saved; the level of positive health is raised; and adults live longer.

United States Civil-Service Examinations for Advisers. The United States Civil-Service Commission announces the following named open competitive examinations: BOYS' ADVISER, SENIOR HIGH SCHOOL, $2600 a year, BOYS' ADVISER, RESERVATION AND JUNIOR HIGH SCHOOL, $2000 a year, ADVISER'S ASSISTANT, BOYS, $1500 a year.

Applications for the above-named positions must be on file with the United States Civil-Service Commission, Washington, D. C., not later than March 25, 1931.

The examinations are to fill vacancies in the Indian Service.

Competitors will not be required to report for examination at any place, but will be rated on their education and experience, and on their published writings or a thesis.

For boys' adviser, either senior or junior high school, applicants must show graduation from a college or university of recognized standing, including or supplemented by certain specified courses, except that two years of suitable experience may be substituted for two years of the college work. In addition to meeting these requirements, boys' advisers, senior high school, must have had two years of certain specified experience, and boys' advisers, reservation or junior high school, one year of such experience.

For adviser's assistant (boys), applicants must have at least fourteen units of high-school work acceptable for college entrance, and two years of certain specified experience, except that one year of additional education may be substituted for one year of the required experience.

Full information may be obtained from the United States Civil-Service Commission, Washington, D. C., or from the Secretary of the United States Civil-Service Board of Examiners at the post-office or customhouse in any city.

HORMONES

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The discovery of insulin gave a new impetus to the study of hormones, the chemical regulators of the body. Since 1922 there has been great activity in this field. The marked progress in knowledge which has resulted is due to the combined labors of organic chemists, biochemists, physiologists, and clinicians. This paper deals with our present knowledge of the hormones found in the various ductless glands. A list of references is appended.

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There is perhaps no more fascinating story in the history of science than that of the discovery of the so-called ductless glands . . . . . OSLER, "Evolution of Modern Medicine."

Had he lived today, Osler might have become even more enthusiastic in recording achievements in ductless glandular research; for in the last ten years or so, thanks very largely to the application of chemical principles in elucidating medical problems, we have made such amazing strides that the years which have gone before appear quite barren by comparison. What was pure fancy before, or even what appeared plausible, has either been ruthlessly brushed aside or else has been confirmed as the result of the objective tests of the experimental worker. For in the field of hormones, which are the active substances elaborated by ductless glands, there was much confusion and little certainty; because, in the first place, the subject lent itself to wild flights of the imagination, and, in the second place, the rigorous methods of the physicist and chemist had not appreciably found their way into this field. All this has changed. Abundant laboratory observations, coupled with more limited clinical observations, have enlarged our sphere of vision to such an extent that a discussion of hormones must now occupy a considerable portion of every treatise on physiology and medicine.

And yet the very word "hormone" was coined but twenty years ago. Bayliss and Starling, two gifted English physiologists, proved that the flow of pancreatic juice into the small intestine was not primarily the result of a nervous excitation at all, but rather the result of a chemical stimulus. When food leaves the stomach and enters the small intestine, the intestinal mucosa discharges a substance into the blood, which then finds its way to the pancreas, and there instigates a flow of pancreatic juice. The name "hormone" was given to this type of substance, from the Greek word meaning "to excite," because the substance *excited* an organ to activity. Hormones are substances found in ductless glands which, under certain conditions, are discharged into the blood, travel through the blood stream, and arouse some other organ or organs to activity. They are the chemical regulators of the body, just as the brain is the nervous regulator. Full coöperation within the body, in fact, requires the harmonious blending of both factors, the nervous and the chemical. That the body is

under the influence of nervous regulators has been known for many, many years; but that, in addition, the body also requires hormonic balance, or chemical regulators, is a comparatively recent discovery. That the body breaks down when the brain stops functioning properly has been a matter of common knowledge from time immemorial; but that the body breaks down just as quickly and just as completely when the normal production of hormones is disturbed is again a discovery of our time.

The progress of the scientist in this field lies first of all in his recognition of these hormones and their importance; secondly, by the use of an experimental technic in being able to locate the particular gland, and therefore the particular hormone, which has either stopped functioning, or is not functioning sufficiently, or shows an abnormal activity—in each case a bad symptom, clinically; thirdly, by the application of chemical principles in preparing extracts which act as substitutes for poorly functioning glands; fourthly, again by the application of chemical principles, in isolating in a chemically pure form the hormone responsible for a particular glandular activity; and fifthly, the pride of the organic chemist, in synthesizing the hormone in the chemist's laboratory.

A number of these progressive steps are beautifully illustrated in connection with the disease known as diabetes. In fact, Banting's arresting discovery of insulin, the all-important hormone involved in diabetes, which occurred in 1922, may be said to mark the beginning of an entirely new era in hormonic research. It gave a feverish impetus to research activity in the field of ductless glands. It led to advances in eight years, the consequences of which we are at present hardly in a position to estimate. It has led a vast army of workers in various fields of chemistry and medicine to join hands in solving problems of glandular physiology, the solution of which, one feels reasonably sure, will do much to decrease the misery of mankind. The cry today is "hormones" just as ten years ago the cry was "vitamins."

Forty years ago two German investigators, Minkowski and von Mehring, showed very definitely that the removal of the pancreas from an animal developed a violent diabetes in that animal. Obviously, the normal functioning of the pancreas (sweetbread) in the body is very intimately concerned with the absence of diabetes in the normal individual. Obviously again, the sufferer from diabetes is a sufferer from a diseased pancreas. But what is there in this organ which contributes to the health of the individual? The same German investigators offered an answer to this question, though the full importance of their researches became apparent much later. They showed that if one grafts a piece of pancreas under the skin of a dog in such a way that a blood circulation is set up with the grafted tissue, and if one then removes the dog's pancreas, the dog does not become diabetic so long as the grafted tissue lasts. The reason for

this is plain enough today. The pancreas, like the intestinal mucosa, elaborates a hormone; but this time the hormone is vitally concerned with the proper utilization of sugar in the body. The grafted pancreas, with proper blood connections, sends its hormone through the blood to the liver, to the muscles, and probably to other organs, *exciting* such organs to function actively in sugar utilization. The grafted pancreas here takes the place of the dog's organ which had been removed.

This *experimental* method of proving the connection between diabetes and the pancreas immediately leads to the important *clinical* conclusion that diabetes in the human being is probably due to a *diseased* pancreas, to a pancreas which no longer functions properly. It suggests at the same time that, by the proper application of chemical principles, it may be possible to extract the hormone from a healthy pancreas and inject it into a person suffering from diabetes, thereby counteracting the effect of a diseased pancreas.

The attempts to obtain an active extract were made repeatedly, with doubtful results, until the year 1922, when Banting and a group of collaborators in Toronto succeeded. Banting's extracts, obtained from the pancreas of various animals, effected not exactly cures but remarkable improvements among diabetic sufferers, and the clinical chemist could also report that the abnormal amounts of sugar in the blood and urine, always present in diabetics, decreased to a value approaching the normal figure. But these extracts have had to be given by injecting them into patients; they are valueless when given by mouth, presumably because the hormone is destroyed by the digestive juices; and it is of interest to note that among all the hormones which have been studied so far, only thyroxin, the active hormone of the thyroid, is definitely active when given by mouth. Another drawback is that such injections have to be continued indefinitely to ensure health. The normal gland in the body is continually manufacturing its particular hormone and thereby enables the substance to be replaced as it is being used up. The diseased gland, unable to do this, or to do it effectively, must have the impaired activity of its crippled cells supplemented by repeated and never-ending injections of extracts containing the hormone.

When one speaks of *active* extracts of the pancreas one means that such extracts contain, among many other impurities, the hormone elaborated by the gland. What is called "insulin" is nothing but such an active extract. It is obtained from the pancreas by a series of chemical operations. An extension of such operations will undoubtedly lead to the eventual isolation of the hormone in a chemically pure state, and to its artificial production. One looks forward with confidence to such an achievement, because such has been the history of two other hormones, adrenaline and thyroxine, both of which are at present made synthetically.

The mere discovery of insulin would hardly have been sufficient to make its use as common as it is today but for a method of standardizing the material, for which we have also to thank Banting and his collaborators. This question of standardizing medicinal products is of the utmost importance. For consider for a moment the problem of the diabetic. He cannot properly metabolize his sugar; insulin helps him to do so. But if you inject too much of the hormone you relieve him of his sugar condition and at the same time bring about other symptoms which may be as bad, or even worse, than his diabetes. Were the insulin in a chemically pure form, it would be possible to weigh out definite quantities of the powder and to inject such quantities as the experience of the doctor would show to be necessary. But the insulin that we have today, and which is administered to the patient, is a mixture of a number of substances not one of which has been definitely isolated. All we can say about it is that it contains at least one substance, which we call the hormone, which is effective in counteracting diabetic symptoms; and we know this not by having isolated the substance, but by the effect the extract has when injected. But not having isolated the hormone, how are we to know how much of it is in any extract we inject? Here the abundant animal experiments of the Toronto group have led to a way out of this dilemma. If we take a perfectly normal rabbit and inject sufficient insulin into it, the animal goes into convulsions after a few hours, at the same time the amount of sugar in the blood is decreased considerably below the normal amount. By the introduction of a number of suitable factors, such an observation can be used to devise an insulin unit. For the sake of convenience, it has been decided that the test animal should weigh four and one-half pounds, and that all food should be withheld from it for a period of twenty-four hours before the injection. One-third of that amount of extract necessary to bring about convulsions in the animal within three hours is called "one insulin unit." In this way uniformity of product is insured; for no matter whether the manufacturer is one in Detroit, or one in London, or one in Tokyo, no matter whether the insulin is extracted from the pancreas of a sheep or dog or any other animal, by adopting this method of standardizing his product he can place on the market his insulin ampules each one of which is the equivalent of a definite number of insulin units; and as the medical boards of civilized countries are very vigilant and the state regulations with regard to such matters are very stringent, the net result is that the practicing physician and his patient can feel confident that they really get what they pay for. As we look back upon the last eight years, and consider the developments in hormonic research, it becomes difficult to say which has had the greater influence on such research, the actual discovery of insulin or the development of a method for standardizing the product.

Five years after the discovery of insulin, that is, in 1927, Harington, an

English biochemist, published an account of the synthetic production of thyroxine, the hormone of the thyroid gland. For the second time in the history of hormones, not only had a hormone been isolated in the chemically pure state, not only had its exact chemical constitution been determined, but, with this knowledge at hand, the substance had then been reproduced in the chemist's laboratory, with properties in every way identical with the product found in man or any other animal!

Harington's achievement is the supreme aim of every scientist working in the field of hormones; it is, first to isolate the hormone and then to reproduce it. When he has isolated the hormone he can study its properties and he can hope to arrive at its chemical constitution; the constitution completed, he can next proceed to make the hormone by a suitable building-up process from other known substances. The difficulties encountered in such work are extreme, but, as experience has shown, they are not insurmountable. And it is then that we sometimes realize to its full extent the kind of miracle worker the scientist may become. For you can take a child who has been diagnosed as a cretin, an ugly child, and an idiotic child, and you can feed him with the thyroxine which this time can be the product of the chemist's laboratory as well as that obtained from the thyroid gland, and you transform this same child into a reasonably normal one. Physically and mentally, the metamorphosis is astounding. We begin to perceive, though dimly, the stupendous possibilities of these hormones. And our amazement is considerably increased when we learn from Kendall, of the Mayo Clinic, that three *tons* of thyroid contain approximately not much more than one *ounce* of pure thyroxine, whereas the entire thyroid of a normal man weighs about two-thirds of an ounce. It is at just such a stage that a disciplined mind is needed for the scientist to stick to the facts of science and not to be tempted into the fantastic regions of the poet, or of one of his cheap modern counterparts, the pseudo-scientist (of which the Greenwich villages of the world are full).

The thyroid is the metabolic regulator of the body: it decides how much and at what rate the foods of the body should be burned. Not so much wonder, then, that he with an insufficient amount of thyroid hormone should develop into an obese and sluggish person, whereas too much hormone produces emaciation and over-activity. The treatment of the hyperthyroid type is difficult; but as has already been suggested, with the hypothyroid, the one possessed of too little thyroid hormone, a judicious addition of the missing hormone to his diet—kept on, however, indefinitely—brings about marked improvement. And in this connection the clinician has at hand a functional diagnostic method for determining the rate of improvement during the course of treatment which represents the united labors of the physicist, the chemist, and the physiologist. It is

called the "basal metabolic test" and depends upon its usefulness for the fact that as the patient improves, his capacity for oxidizing his foodstuffs becomes greater.*

The isolation and the synthesis of thyroxine (the hormone of the thyroid gland) were preceded by the isolation and synthesis of a hormone present in the adrenal glands: adrenaline. This adrenaline, which when injected has a powerful effect in raising blood pressure, has played a central part in Professor Cannon's "emergency" theory, which postulates that in times of stress, of fear, and of pain adrenaline is discharged into the blood, which in turn causes a mobilization of body fuel, in the shape of carbohydrate, and "emergency" requirements are thereby supplied. Be that as it may, adrenaline is not the only hormone of the adrenal glands, nor does it seem to be the most important. If we examine these glands, which are small bodies situated above the kidneys, we find that they consist of two distinct types of tissue known as the medulla and the cortex. It is generally believed that the medulla, in which adrenaline originates, is not essential to life, whereas the cortex is. A diseased cortex, it is now believed, is in some way involved with a somewhat rare and fatal illness, first described by an English physician, Addison, in 1855, and now known as Addison's disease, involving among other symptoms a peculiar pigmentation of the skin. Within the last few months, Dr. Swingle of Princeton has prepared an extract from the cortex which has saved the lives of several sufferers from this hitherto incurable disease. This extract undoubtedly contains the active hormone, though we are far, as yet, from the actual isolation of the substance.

The chemist makes thyroxine and adrenaline in his laboratory; he needs no glands for preparing these hormones. But in the preparation of insulin and of the hormone from the adrenal cortex, the appropriate glands are necessary as starting material. Here, let it be emphasized again, even though we have "active" extracts, we have not, as yet, succeeded in isolating the hormone in a chemically pure state; and until that is done, synthetic attempts to manufacture the substances cannot be undertaken. What is true of insulin and of the hormone of the adrenal cortex is true of the hormones of the pituitary and of the reproductive organs, concerning which some very remarkable discoveries have been made recently.

The pituitary, situated in the head, and less than one-thirtieth of an ounce in weight, is divided into two parts, the anterior and the posterior. The posterior part, like the medulla of the adrenals, is probably the less important. Dr. Kamm has obtained evidence for the presence of at least two hormones in this posterior portion; the first has the power of raising

* Associated with the thyroids are smaller organs known as "parathyroids." From these Dr. Collip has obtained an abstract—the parathyroid hormone—which is very potent in regulating the calcium metabolism of the body.

blood pressure, and the second, of causing a contraction of uterine muscle. The anterior portion of the pituitary, however, seems to play the more dramatic rôle. It has long been known that this part of the pituitary is an important factor in the growth process. An over-production of glandular secretion may give rise to gigantism, and an under-production to dwarfism. Within recent years, Professor Evans has for the first time succeeded in preparing extracts which, when injected into rats, give rise to "giant" animals. But aside from the growth-promoting hormone which is present in the anterior lobe of the pituitary, there is a sex-promoting hormone there also.

It was pointed out some years ago that during pregnancy some very definite histological changes take place in the anterior lobe of the pituitary. Within the last few years it has been shown very definitely by Drs. Evans and Smith in this country and Drs. Aschheim and Zondek in Germany that the implantation of the anterior lobe, and, in a number of cases, the injection of extracts, causes precocious sexual maturity in young rats and mice. The German investigators also observed that during pregnancy an overdose of the sex-promoting hormone was produced by the pituitary, and an appreciable amount of it found its way into the blood and into the urine. When the urine of pregnant women was injected into immature female mice, striking changes in the ovaries were observable. This at once led to the view that such a reaction could be made the basis of a test for pregnancy; and such, indeed, has been its development. The Aschheim-Zondek pregnancy test is already being carried out in every large hospital in the world.

From the ovary and from the placenta Drs. Allan, Doisy, Zondek, and others have prepared extracts which, when injected into castrated mice, produce estrus ("heat") in the animals and, in general, offset many of the effects of castration. Such extracts will hasten the maturity of infantile animals. Apparently we are here dealing with a "female sex hormone." Upon this hormone much energy has lately been expended. A number of investigators have already obtained it in what appears to be a chemically pure state. Here, as in the case of the pituitary hormone, the waste product of the body (the urine) is found to be a very convenient source for the preparation of the hormone. This might be anticipated from the theory of hormone action; for since hormones are discharged into the blood, and since many of the substances in the blood are also found in the body's chief waste product, we might expect to find hormones in urine.

Apparently we do. From the male reproductive glands Dr. Koch and his collaborators have succeeded in preparing an extract which, when injected into castrated cocks, causes, among other things, remarkable increases in the sizes of the combs and wattles. Drs. Funk and Harrow have been

able to prepare a similar extract from the urine of males. We are here dealing with something in the nature of a "male hormone."

The era of hormones is but beginning. One need not be over-enthusiastic to prophesy further amazing developments along these lines—developments of a chemical and of a clinical nature. But it is just in the midst of such possibilities that the scientist must remain true to his profession and be hyper-critical of every statement and of every experiment. It is just at this stage that the scientist must temper not only his enthusiasm but that of the layman. It is particularly then that he must combat with vigor every attempt of the charlatan to profit by the state of flux in which the subject finds itself.

Bibliography

General

A general introduction to the entire subject will be found in Benjamin Harrow's "Glands in Health and Disease" (Dutton, **1928**), in which are included many references, particularly to the older literature.

Thyroid

In "Thyroxine" (Chem. Catalog Co., **1929**) Kendall describes his work on the active principle of the thyroid gland. Harington's contributions, dealing with the exact chemical constitution and the synthesis of thyroxine, are to be found in the *Biochem. J.*, **20,** 293 (1926) and **21,** 169 (1927).

The Parathyroids

A very complete review of Collip's work on the isolation of the active principle is given by Collip himself in the Harvey Society Lectures, 1925–26 (published by Lippincott).

Pituitary

Abel's extensive work on the chemistry of the posterior lobe of the pituitary is reviewed in *Ind. Eng. Chem.*, **16,** 1031 (1924). Kamm's important article has appeared in the *J. Am. Chem. Soc.*, **50,** 573 (1928). A review of Kamm's work has also appeared in *Endocrinol.*, **12,** 671 (1928). The pioneer work of Evans on the anterior lobe of the pituitary, in which he showed that extracts could be obtained which affected growth and the female reproductive cycle, is reviewed in the Harvey Lectures, 1923-24. Further important work along these lines we owe to Smith [*Am. J. Physiol.*, **79,** 184 (1927)] and Zondek and Aschheim [*Arch. Gynakol.*, **130,** 1 (1927)]. The last two authors also suggested the pregnancy test [*Klin. Woch.*, **7,** 831, 1401, 1453 (1928)] which has since been widely adopted.

Adrenals

Abel's pioneer work on the chemistry of adrenaline is reviewed by him in *Science* (October 14, 1927), p. 339. A preliminary account of Swingle's success in isolating the active principle of the adrenal cortex is to be found in *Science* (March 21, 1930). A striking clinical application of the hormone, used in Addison's disease, is discussed by Rowntree in *Science* (Sept. 7, 1930). Active extracts of the adrenal cortex have also been obtained by Stewart and Rogoff [*J. Am. Med. Assoc.*, **92,** 1569 (1929)] and by Hartman [*Am. J. Physiol.*, **86,** 353 (1928)].

PANCREAS

The articles on insulin are numerous (see the book on "Glands," by Harrow). Two papers of historical importance may be mentioned: one paper is by Banting and Best [*J. Lab. Clinical Med.*, **7**, 1 (1922)]; and the other is by Collip [*Canadian Med. Assoc. J.* (Sept. 1924)].

FEMALE HORMONE

The pioneer work of Allen and Doisy is described in the *J. Am. Med. Assoc.*, **81**, 819 (1923). This work—and all succeeding work on the female hormone—has been made possible by Stockard's discovery of the changes in cell types found in the vagina of the guinea pig during the sexual cycle [*Am. J. Anat.*, **22**, 225 (1917)]. A large amount of work has since been done on the chemistry of the female hormone, notably by Doisy [*J. Biol. Chem.*, **86**, 499 (1930)], Butenandt [*Z. physiol. Chem.*, **188**, 1 (1930)], Marrian [*Biochem. J.*, **24**, 1021 (1930)], and Laquer [*Deutsch. Med. Woch.*, **56**, 301 (1930)]. R. T. Frank, himself an active worker, has published a book on the female sex hormone (Chas. C. Thomas, publisher, **1929**).

MALE HORMONE

Koch, Gallagher, and Moore [*Endocrinol.*, **13**, 367 (1929)] and Funk and Harrow [*Am. J. Physiol.*, **92**, 440 (1930)] are pioneers in this field. Very important work has also been done by Dodds [*Lancet*, p. 683 (1930)] and by Laquer [*Klin. Woch.*, **9**, 772 (1930)].

A CONVENIENT DEVICE FOR THE CALIBRATION OF A SPECTROSCOPE

BEN H. PETERSON, COE COLLEGE, CEDAR RAPIDS, IOWA

The handbooks give the wave-lengths or frequencies for the flame spectra for a number of elements. These may be used in plotting against the scale reading of the instrument to obtain the calibration curve. Considerable difficulty was experienced in our laboratories in obtaining a spectrum of sufficient duration by using a platinum wire dipped in the solution being studied. The following scheme was then adopted and found to serve very well. Solutions of the chlorides of Ba, Sr, Ca, Na, K, Tl, and Li were prepared and placed in wide-mouthed bottles of about 100 cc. capacity. These were fitted with corks through which a nichrome wire was run. The end of this wire was wrapped around an asbestos fiber wad. When the bottle was corked, the wad was immersed in the solution. To use, the cork is removed and most of the solution pressed out of the wad. It is then placed in the edge of the colorless Bunsen flame. The spectrum of the element being observed stands out so prominently that the contaminating lines of the asbestos material do not interfere. The scale readings of the principal lines are thus obtained and plotted against the wave-lengths or frequencies obtained from the tables. In using, the prism is then always adjusted so that the principal lines of some elements, say Na and Tl, always fall on the same scale reading.

TEACHING SCIENCE AS A "WAY OF LIFE"*

JOHN L. TILDSLEY, HIGH SCHOOL DIVISION OF THE BOARD OF EDUCATION, NEW YORK CITY

The conception of science teaching herewith presented is revolutionary in that it calls for the abandonment of mastery of subject matter as a completely satisfying objective and makes this objective subordinate to the development of qualities, habits, and attitudes which ultimately the teachers believe will bring about a new and better social order.

The writer maintains that the scientific spirit must be welcomed in the distribution of the product of industry as in its creation, if America is to escape disaster.

Answers from 16,000 pupils of New York high schools indicate that some of them are coming to view science as a force in the making over of their lives; that under the leading of teachers who know the "way," these boys and girls vision a richer, a larger world in which they too may walk, larger.

. . . . .

This may seem to many of you a most fantastic title for a most prosaic process. You must feel that I am giving full rein to my imagination. Allow me to assure you that I, unfortunately, am not the possessor of a highly developed imagination. This very descriptive title was not created by me. It came to me without volition on my part, forced upon me as the only possible title to express my conviction after reading the contributions of some 600 teachers of science in the high schools of New York City some two years ago.

Teachers' Objectives

One teacher after another told me he sought in his teaching of biology, of chemistry, of physics,

to arouse in pupils curiosity concerning natural phenomena,
to develop a sense of the wonderful and beautiful in nature,
to enjoy with pupils the discovery of the scientific causes underlying the phenomena they have observed,
to offer at least one additional item of value for a richer life at each lesson,
to make the world a more interesting place in which to live,
to cause them to see the wonder and beauty of it all,
to get an emotional response so they will be living in a larger world in the sense of Plato's magnificence of mind,
to appreciate the beauty and harmony of the world of nature,
to put over to each pupil the unity and wonder of life,
to feel that law and order are laws of the universe,
the development of intellectual curiosity resulting in individual efforts for knowledge,
the ultimate acquisition of freedom which truth gives,
to bring out the unity of life,

* A talk to the Science Teachers of the Middle States and Maryland, Atlantic City, New Jersey, November 29, 1930.

to prepare pupils for a richer life,
to develop creative thinking,
to inspire the pupils to seek mastery of that which took so much vision and so much boundless enthusiasm on the part of makers of science to attain,
to develop scientific skepticism,
to develop the tendency to put doubtful conclusions to an experimental test,
development of power and willingness to weigh evidence and postpone judgment,
openness to new ideas and willingness to suspend judgment,
learning to search for truth and not to take it on authority,
to discourage actions resulting from tradition, superstition, and the playing of hunches,
ability to test the truth of a conclusion,
to develop tendency to put doubtful conclusions to an experimental test,
to build up a truth-seeking attitude,
to arouse a love for truth,
to impress pupils that truth is the necessity and mainspring of their existence,
to place truth above everything,
to arouse in pupils respect for intellectual courage,
to train pupils to act in accordance with their knowledge,
to make pupils feel that it is a crime to let others do your thinking for you,
to develop an attitude of open-mindedness and tolerance,
to foster social-mindedness,
to distinguish between essentials and non-essentials,
to develop in the young a sense of values,
to build up the habit of getting clearly in mind—What am I trying to do?
to produce in pupils that clearness and definiteness of thinking and expression which lead to beauty of life.

Each objective I have quoted is the objective given by an individual teacher. These are but some of many I might have quoted. As evidence that I am not altogether misrepresenting the attitude of our 600 teachers of science, may I cite that no less than 255 teachers state with some variation in phraseology as their fundamental objective is—"to develop in pupils an appreciation of the scientific methods of thinking and the habit of applying this method to other than strictly scientific subject matter."

From this recital you will agree with me, I am sure, that a large proportion of the teachers of science in New York City are honestly desirous of leading their pupils into an abiding faith in the spirit and method of science as applicable to all the affairs of life and so giving us in truth a "way of life."

Moreover, these objectives were not evolved for the first time for the purposes of this study. In the statement of the Creed of De Witt Clinton High School of November, 1924, we find,

In the teaching of biology we aim to develop open-mindedness, reliance upon facts, and to train in arriving at a logical conclusion.

From the department of chemistry:

(*a*) The method by which science does its thinking is decidedly different from methods used in other domains. (*b*) Science has had success with its methods star-

tlingly greater than in any other cases. (*c*) Since it is only mind, intelligence, and reasoning which solve problems, there is fair justification for the assertion that the method of science can be applied in other fields.

In consequence of these principles, there is a moral imperative on science teachers to (*a*) analyze the science method of thought, to discover the characteristics which differentiate it from older types; (*b*) make the pupil conscious of the method of science as well as of the mere results of science; (*c*) experiment somewhat in having pupils use the method both in science and in other subjects.

To put it briefly, we are now entertaining the idea that our major objective in teaching chemistry should be to teach pupils how to think, thus how to attain integrity in the mental processes and finally to intellectual morality.

The department of physics gives us its objectives as: (*A*) to train men to correct methods of thinking by accustoming them (1) to distinguish between facts, theories, fancies; (2) to keep the mind free for the reception of new evidence; (3) to form opinions on the basis of facts even when these are unpleasant and opposed to present ideas; that is, to avoid errors of reasoning due to the personal equation; (*B*) (1) to make man conscious of his power over nature and so greatly to enlarge his range of self-expression; (2) to develop scientific imagination, to associate force with phenomena, men must think of things in motion as well as in a static condition.

From these numerous quotations setting forth the convictions or, if you prefer, the aspirations of our teachers of science in New York, you must begin to realize that we are in the first stages, at least, of a revolution in our philosophy of education if we have not all advanced to the revolutionary stage in our practices. We are in the ebb tide of our Voltaires and our Rousseaus. We have the beginnings of the flood tide in a few men like the chairmen of this meeting.

We are beginning, many of us, with regrets, to abandon mastery of subject matter as a completely satisfying end in itself. For very many, it is a real wrench to abandon the College Entrance Board Examination or the Regents Examination as the safe and comfortable haven of our voyage and become veritable Ancient Mariners sailing over as yet uncharted seas for a harbor that ever recedes as our vision expands of the possibilities of our boys to attain more distant and glorious ends.

Our science teachers do stand with the teachers of the "progressive schools." They do stand for a child-centered school, a school which has at all times the fullest possible realization of the possibilities of each child as the goal of its conscious efforts. They agree with the teachers of the "progressive schools," that subject matter is merely raw material which we use in the education of the child. They further agree with them in setting qualities, habits, and attitudes as the objective of education rather

than the building up of masses of knowledge or even a carefully planned structure of knowledge, or the development of mere skills.

A study of commercial education we completed a year ago revealed that the great business institutions of New York were not seriously concerned with what their young employees knew when they came to them from the high school nor even with what they could do; but they were most seriously concerned to find out whether these young people were accurate, were thorough, whether they could finish an undertaking once entered upon, whether they had high standards of achievement, whether they were dependable, whether they were reliable, whether they possessed a certain degree of initiative.

Our science teachers are in entire accord with the business man in also seeking to realize these objectives. They are inclined to believe that these qualities almost necessarily result from any genuine attempt to gain even a partial mastery of the method of science and of the content of high-school science.

But our science teachers are not satisfied with building up those qualities which make for success in business, nor with creating abiding interests such as a love of Nature in all her manifestations, an appreciation of the beautiful in all its forms, nor even with the development of "an intellectual curiosity which knows no end."

They see in the teaching of science a means of creating a new and better social order as the result of sending out year by year boys and girls with outlooks on life transformed as the result of their study of science. This transformed outlook they are confident will come as a result of exposure to, and some slight practice in, the use of the scientific method. It will arise in greater degree as a result of their knowledge and understanding of the motives and manner of life of the scientists who through the ages have labored with little thought of self for the enlargement of the domain of truth; men who have contributed, without thought of reward, the results of their study to the common stock, men who were content if not even the society in which they lived but society of a century hence should be richer, better, nobler, because of their studies.

Students of society are seriously concerned over the future of America. Our economic order shows signs of weakness in its foundations. It is sometimes felt that the doctrine of the survival of the fittest borrowed from science but applied in human relationships may produce a social order dominated for a time by the most fit to survive a purely individualistic, selfish struggle for existence, but a social order necessarily bringing anarchy in its train unless, before it is too late, other forces be brought to play. Our science teachers are apprehensive of catastrophe unless there shall be built up in the youth of the land the scientific method of coöperation, the scientific habit of giving all that one has and is to the common store, the willing-

ness to forget self in one's interest in the larger group, the ability to recognize and courageously deal with the tendencies, the forces which are destructive of continuing social well-being.

Practically every one is willing to admit that the age in which we live with its multiplied resources for comfort and ease, and enjoyment for the many as not before for centuries past is very, very largely the product of science. The scientist has been the most welcomed contributor on the side of production. His ideas have been accepted as the final authority in industry after industry in the function of production but in that function only. When the business man turns to the function of the distribution of the product which is due in such great measure to the far-flung, all-pervasive influence of the scientific spirit, he no longer recognizes the validity of the guiding principles of science. He substitutes a doctrine of "keep all you can" for the scientific principle of "share all you have" for the common good. Reductions in the cost of production due to the freely shared discoveries of the great company of searchers in the various fields of science have in too many cases not been passed on in lower prices to the ultimate consumer. High prices have been maintained and the excessive waste of high-power salesmanship, of enormous advertising costs, have been invoked to dispose of the mass of goods our scientists have brought into being. So our economic structure shows signs of slipping and people begin to wonder whether the contribution of science has been a blessing or a curse.

Thorndike tells, according to Wiggam, that there seem to be three fairly distinct intelligences, the mechanical, the abstract, the social. We are all accustomed to the idea that science and mathematics are the special stuffs for the abstract intelligence. It is time for us, as educators, to realize that science of all subjects gives the social intelligence most that it needs for its fullest development.

Biology offers to the social intelligence or to society itself the example of the balanced aquarium, with its continuous and uninterrupted well-being for plants and fishes due to a fair partnership, each giving and receiving in a spirit of equity.

The human aquarium has gotten out of balance. Our bankers, captains of industry, our statesmen tell us there is too much production. Although millions of men and women are hard pressed to live, not one of our leaders has the intelligence or possibly the honesty or the courage to tell us that the disease from which American society is suffering is underconsumption.

If the contribution of science to the wealth of America during the years since the war had been distributed in the same spirit in which it was produced, the spirit of coöperative sharing in a common social enterprise, we would have had fewer millionaires but also in all probability no millions of

unemployed. We would balance the absence of billionaires with the absence of the unwilling non-worker.

If our American society is to survive as a civilized society it must accept from the scientist not merely the technic of new forms of production and a resulting vastly greater product but it must accept from him the spirit of unselfish service, of contentment with contributing one's bit to the common cause, the spirit of coöperation rather than competition. It must accept from him the willingness to weigh evidence, acknowledge error, experiment, seek for the truth, above all courage to act on the truth when found.

Acceptance from science of what serves our selfish purpose, rejection of what makes us personally less comfortable inevitably leads to social downfall. This is the great truth our teachers of science should weave into the very web of their pupils' selves.

If our society is to increase in well-being, it must take from the scientist a willingness to challenge the eternal necessity of that which is, whenever it brings with it so much that is distressful. Economic science has given us the "business cycle." Bankers and leaders of industry cite it as being as inevitable as the law of gravity. The present partial collapse of our economic order is explained as merely a passing phase of the heaven-ordained inevitable business cycle. Some keener Einstein imbued with the spirit of science and with no bias of self interest as he observes industrial phenomena and studies their significance untrammeled by a brief for the established business order will undoubtedly discover that the business cycle is neither a law of nature nor a valid excuse for our recurring periods of privation for millions of willing workers.

Do you begin to see why some teachers conceive the teaching of science as teaching a way of life? If you do, your next query naturally is—to what extent are the teachers of science in the New York high schools building up in their pupils a desire and willingness to accept for themselves the spirit, teachings, and practices of science as a way of life?

Pupils' Testimony

In unsigned answers to questions, 6117 of some 16,000 pupils enrolled in science classes of the third and fourth years told us that the study of science had increased their realization of man's control over his environment; 5403 said this study had made them demand evidence before accepting general statements as true; 4879, that it had made them more open to new ideas; 2873, that it had lessened the effect of prejudice in arriving at judgments; 3375, that it had helped them to base actions on the results of their own observations and reasoning and less upon traditional action or the consensus of opinion of their group; 5603, that it had aroused a greater appreciation of things out of doors.

Some typical answers to these questions are:

It has made me appreciate the little plants and flowers more because I know now they are just as important and do as much work as we do,

It has made me realize the significance of and the beauty of all living things,

I have attempted to prove for myself the laws of magnetism,

I have tried experiments to prove Newton's third law,

I have experimented with convex and concave lenses,

It has made me think that truth is the main thing,

I have realized the error of being too positive in my statements,

Our teacher would always ask—"How do you know?" when we made any statement so that I have gotten into the habit of always demanding evidence when I hear statements by my friends,

The study of biology was such a revelation of facts hitherto unknown to me that I am now ready to listen to anything in the way of new ideas,

When you see what has been done through science it seems that there is nothing impossible,

In science one's mind has to be unprejudiced before making experiments,

When you read that most scientists were laughed at, imprisoned, or burned in olden days for their observation and discoveries you learn to aid rather than retard one who thinks he has arrived at a new truth,

I break away from my fellows when I want to get some real ideas. I can't be too individualistic, however, for that would be becoming an outcast, although I prefer my own ideas,

In certain sciences I was so accustomed to base my actions on what I learned by observation and experimentation that I began to do it in all subjects, rather than take for granted the words of others,

I learned that great men like Aristotle even had a wrong idea and thus my own ideas were encouraged,

I am not yet firm enough either in will or mind to base my actions long against tradition,

I now realize that good habits make a free person,

From my study of science, I have gained the knowledge of how to live better and how to better myself in living,

I have gained only the knowledge of how little I know,

I have gained a desire to see below the surface and know of the inner, secret workings of things,

The idea that success can be obtained only through hard diligent work and long experimentation. This idea was impressed upon my mind by the work of such men as Newton,

The will to be accurate and logical. The desire to keep an open mind,

An appreciation of science and enough foundation to enable one to direct his life in accordance with the best ways,

I think I shall always remember that this course gave me just another insight into another world, one of the many worlds into which many of us will not enter. Each world has its own great man and great works.

I am sure you will all agree that this testimony of pupils indicate that some of our 16,000 pupils who were questioned had come to look upon science as pointing to them the "way of life."

Teaching Technic

Have the teachers of such pupils a special technic? Is there a methodol-

ogy of teaching science as a way of life? Would you be able to recognize as you enter a classroom that the teacher was of design teaching physics or chemistry or biology as a way of life?

To questions one and two I would answer—No. To question three I would say, perhaps. Only this past Tuesday I visited an advanced biology class. The teacher was leading a discussion on whether acquired characters could be transmitted. The evidence against transmission was presented by a pupil. Another pupil reported that the weight of evidence furnished by experiments with the vinegar fly was against transmission. Undismayed by this citation of evidence, one thoughtful boy said, "This theory of non-transmission seems to me to be silly." No one chided him. The teacher merely called for more evidence.

The secret of "teaching science as a way of life" does not lie in a methodology but in the teacher. The teacher himself must be a master of his subject, open to new ideas, unprejudiced, intellectually curious, tolerant, enthusiastic, honest, truthful, unselfish, a lover of youth, understanding and sympathetic with the problems of youth.

A graduate of a Brooklyn school met one of the science teachers. He asked after Mr. C. and said, "He is the man who taught us to be honest and truthful." Mr. C. is a master of physics, and a master of the teaching art. This boy knew his physics but what he prized in this master teacher of physics was that he taught his boys to be honest and truthful.

The teacher of science whose great objective is to build up in his pupils qualities, habits, and attitudes does not make a lesson plan for Tuesday in which he provides an outline for teaching unselfishness, for Wednesday the development of objectivity. Rather each day he teaches by example what he himself is, he teaches physics, he takes up the dynamo and shows what long exacting experimentation took place under Faraday and his successors, what pooling of experiences, what gifts of discoveries made, what great social service rendered without reward before we could have at our disposal the machine of today. As he teaches the method of science, the accuracy of its processes, the validating of its conclusions, he points out the dangers to society by concrete examples of other more hasty processes. He does not drag in these higher values. They arise naturally in the routine of developing the principles and achievements of the special science.

The biology teachers in their treatment of Pasteur have probably accomplished more than by any method in inculcating the appreciation of unselfishness, of thoroughness of mastery of technic, even of such qualities as open-mindedness and tolerance.

An inquiry revealed that the students had not gained as much from the biographical features of their work as we had hoped. The reason I believe is too much referring boys to articles in the encyclopedia. It is most unfortunate that every great scientist has not had a Vallery-Radot. In the

absence of such the teacher must substitute his own enthusiasm and understanding of what appeals to a boy for the genius of the biographer.

Make no mistake. Teaching science as a "way of life" is not an easy task except in so far as hard work which gets one somewhere always seems easy because it is so satisfying. There is no soft pedagogy about it. It is not a matter of telling. It is not a matter of amusing. It is a process of weaving into the daily task of leading the boy to mastery of a small, intensively cultivated field of science, all the enriching, illuminating, inspiring remembrances of men known, of books read, of laboratory thrills experienced, of scenes visited, of relations visioned, all the teeming mental life of the teacher, who having taken the vows to walk in the spirit of science and follow in the footsteps of its great masters, grows each year more joyfully optimistic through intimate contact with inquiring, despairing, triumphant youth, attains to greater faith in the value of his ministry to youth, to society, and so to himself.

A RAPID METHOD OF ADJUSTING ANALYTICAL WEIGHTS

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The method here outlined is applicable only to two-piece weights. Strips of the metal foil used for Christmas tree decorations (about 2.5 mm. wide) are cut into equal lengths, say 20 cm. These are weighed and placed on a piece of rough paper, laying successive strips side by side, making sure that they lie smoothly. Another sheet of paper is fastened over the first by gluing firmly around the edges. From the weight of the total strip, the weight of a convenient length can be calculated and cut by means of a sharp paper-cutter. A 1 cm. length will weigh about 4 mg. Units of 4, 2, and 1 mg. can be cut with a fair degree of accuracy. The weight to be adjusted is balanced against a standard or high-grade analytical weight and the correction to be added noted. This amount can be rapidly picked out of the supply of the strips prepared in the above manner. The knob of the weight is removed, the foil placed in the cavity and the knob replaced. Smaller pieces of foil can be cut from the strips if needed. It is possible to adjust a set of weights in less than an hour with a precision of 0.2 mg.

A very convenient method of cleaning the weights preliminary to adjusting is as follows. Wrap the knob of the weight in a small piece of felt and clamp in the chuck of a stirrer. Polish the rotating weight by holding a piece of polishing cloth against it. With ordinary silver polish the weights can be easily cleaned of stains or corrosions.

A high-grade colorless lacquer will then adhere very well.

THE UNIVERSITY AND FUNDAMENTAL RESEARCH*

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The great advances in science have in general been the result of the research work of many individuals and in many instances arose from some apparently (at that time) insignificant but fundamental scientific observation.

The scientific genealogy of a research worker may be much more important than his blood genealogy.

. . . . . .

"What does chemistry mean to me?" said Mr. Averageman, as he looked at the page printed with ink made by a chemical process. As he pushed back his cuff, bleached by a chemical process, and laced his shoes, made of leather tanned by a chemical process, he glanced through a pane of glass, made by a chemical process, and saw a baker's cart full of bread, leavened by a chemical process, and a draper's wagon delivering a parcel of silk, made by a chemical process.

He pulled out his pencil, made by a chemical process, and wrote a reminder in his notebook bound in imitation morocco, made by a chemical process. Then he put on his hat, dyed by a chemical process, and stepped out upon the pavement of asphalt, compounded by a chemical process, bought a daily paper with a penny refined by a chemical process, and proceeded to the office where he dealt in a certain compound called coal.

"No," he added, "of course not, chemistry has nothing to do with me."

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So wrote N. H. Casson, an editor, several years ago.

For a moment or two I wish to point out that the great modern chemical industries, the products of which contribute so much to our present comfort and well-being, did not spring suddenly into being but in most instances arose as the resultant of some apparently insignificant but fundamental discovery.

Only one hundred years ago, in 1828, Wöhler prepared for the first time in the chemical laboratory an organic chemical compound, urea. Prior to that time the "organic compounds," of which urea is a representative, were thought to be formed only by vital processes. A vital principle was necessary! Without a vital principle Wöhler prepared urea, and the modern age of synthetic organic chemistry began. Since Wöhler's discovery literally hundreds of thousands of organic compounds, many of which we now regard as indispensable to our well-being, have been prepared in the chemical laboratory.

In 1839, Charles Goodyear noted that when sulfur was added to crude rubber and the mixture was heated, a new product of unique properties was obtained, and that observation has made possible the entire rubber industry and the automobile industry of today.

In 1886, Charles Hall, then an under-graduate student at Oberlin, found a few metallic globules of aluminum in one of the experiments on electroly-

* An address delivered at University Convocation, University of Minnesota, October 31, 1929.

sis which he was conducting. Prior to that time, metallic aluminum was more rare than is platinum today. Hall at the time he made that experiment was filled with scientific curiosity. He had no thought that his experiment would create the enormous aluminum industry of today.

Perkin, in 1856, when he was eighteen years old, attempted an investigation of the chemical nature of quinine. He did not solve his problem; no one has completely solved it even today; but he did create mauve, the first of the so-called aniline dyes, and our entire dyestuff industry dates from Perkin's researches.

Pasteur, when he studied the disease of the silkworms and the reasons for abnormal and undesirable fermentations of beer, did not visualize the fact that he was creating not only the science of modern medicine, but likewise the modern industry of food preservation, the canning industry, the pasteurization of milk and fruit juices, and even our modern methods for insuring the purity of our water supply.

Osborne and Mendel, in 1911, when they attempted to test the old theories of Liebig that a certain amount of protein and a certain calorific value of the diet were all that was necessary for the maintenance and growth of animals, did not visualize that their experiments would change in a radical manner our conceptions of human and of animal nutrition and would point the way whereby a farmer, feeding a properly balanced diet, could secure greater gains and higher quality at a lower cost.

Eijkmann, when he undertook in 1890 his investigations of the disease beriberi which had decimated the Japanese navy, had no idea that this would lead to the discovery of an entirely new field in nutrition, but the fact remains that all vitamin research dates back to his pioneer work.

Babcock, at Wisconsin, searched for a simple and rapid method whereby he could analyze cream for its fat content. He found a technic which the average farmer could use, and the result was the "Babcock Test" and the saving of literally millions of dollars to the dairy farmers of America, since they could thus demand payment for their product in proportion to its content of butterfat.

Chandler, at Columbia, devised a special specific gravity spindle, and when he applied it to the study of milk he discovered that the milk which was being delivered in the city of New York had, almost without exception, been diluted with water. He refused to patent his "lactometer," for he said he wished it to be used everywhere so that the watering of milk could be readily detected.

The Curies investigated a rare mineral which even in the dark would leave a photographic image of itself upon a sensitized plate even though that photographic plate were wrapped in many layers of black paper, and their investigations resulted in the isolation of radium, a boon to medicine,

and in a complete revolution of the mode of thought underlying the sciences of physics and chemistry.

The discovery of helium in the Frauenhöfer lines of the sun's spectrum is a far cry from the giant dirigibles which are now being constructed for the United States government.

Sir William Ramsay found fifteen parts of the rare gas, neon, in a million parts of the earth's atmosphere and today the neon signs give brilliance to our streets and bid fair to revolutionize the electric lighting industry.

And so one might continue adding name on name and accomplishment on accomplishment. In most instances the original observation was the product of a true scientist who had no other thought than to wrestle from nature the solution of some of the mysterious phenomena of the universe. No thought of gold or fame for himself, only the thought that the next generation of mankind would be wiser than his own!

It must not be thought that the persons I have mentioned completed their work. Hundreds of thousands of others added their mite of fundamental research before the present-day status was reached, and the end is not yet.

May I quote from President Hoover's recent address at the celebration of the fiftieth anniversay of Thomas A. Edison's invention of the incandescent electric lamp? He said,

> I may emphasize that both scientific discovery and its practical application are the products of long and arduous research. Discovery and invention do not spring full-grown from the brains of men. The labor of a host of men, great laboratories, long, patient, scientific experiment build up the structure of knowledge, not stone by stone, but particle by particle. This adding of fact to fact some day brings forth a revolutionary discovery, an illuminating hypothesis, a great generalization, or a practical invention.
>
> Research both in pure science and in its application to the arts is one of the most potent impulses to progress. For it is organized research that gives daily improvement in machines and processes, in methods of agriculture, in the protection of health, and in understanding. From these we gain constantly in better standards of living, more stability of employment, lessened toil, lengthened human life, and decreased suffering. In the end our leisure expands, our interest in life enlarges, our vision stretches. There is more joy in life.

No institution is worthy of the name of a university unless it combines both teaching and research. Teaching without contributing to knowledge is at the best a parasitic existence. No stream will ever reach the ocean unless there is a never-failing inflow of water at its source. No university can accomplish its ultimate mission without contributing to the fund of the world's knowledge.

The highest, the ultimate reward of the true university professor is not reached when all of his students can write perfect examination papers, when they can all recite parrot-fashion all of the facts and theories enumerated in the textbook. The real joy comes when one, or two, or perhaps

half a dozen students who have come under his guidance catch the fire of inspiration, become impatient with the meager fragments of knowledge which are handed out in the classroom, and start out for themselves to push back the barriers of the unknown. Then the professor can pass on to younger hands the torch which he has been carrying and can feel assured that his life and his teaching have not been in vain, that some one more gifted than he will carry on into succeeding generations.

I do not know the human genealogy of Faraday, I care not to know it, but I do know that Sir Humphry Davy said that his greatest discovery was Michael Faraday, and if we were to trace the scientific genealogy of our scientists, we would find that much more important than their blood genealogy. The teacher, the researcher, lives in his students and in their students in succeeding generations. That is the teacher's reward. That is true immortality.

Leprosy Now Attacked by Chemical Warfare. Scientists have resorted to chemical warfare in what is hoped will be a decisive attack on one of mankind's much-dreaded foe, leprosy. As a beginning in their efforts to find an agent useful in fighting the disease, the chemists will make an intensive study of the germs that have been grown from cases of leprosy, in contrast to the recently studied germs of tuberculosis, for the leprosy germ belongs to the same family.

The same group that is studying the secrets of the tuberculosis bacillus has been asked by the Leonard Wood Memorial to undertake the study of leprosy. The research will be directed by the Medical Research Committee of the National Tuberculosis Association, of which Dr. William Charles White, of the U. S. National Institute of Health, is the chairman.

As in the recent attack on tuberculosis, hundreds of thousands of leprosy bacilli will be grown in the laboratories of the H. K. Mulford Co. These will be taken to the Sterling Chemical Laboratory of Yale University where they will be analyzed under the direction of Prof. Treat B. Johnson. At the same time the clinical studies with leprosy patients will be carried on at the government institutions for the care of lepers and in those of the Leonard Wood Memorial.

The tuberculosis investigators and fighters have been called in to study leprosy because of certain similarities between the diseases. For instance, the germs causing the two diseases are members of the same family. They even grow in the same cells of the human body, the monocytes. The germs of tuberculosis, however, invade mainly certain parts of the body, such as the lungs, while the leprosy bacilli occur chiefly in the skin.

Some 15 or 20 strains of lepra bacilli have been cultivated from human cases, but until recently it has never been possible to produce leprosy in any animal by transferring any of the germs to the animal's body. The accomplishment of this feat has just been announced by Prof. K. Shiga of the Imperial Medical Faculty at Seoul, Korea. He claims to be able to produce leprosy in rats by injecting the lepra bacilli into rats whose powers of resistance were weakened by having lived on a diet lacking in vitamins.

Why vitamins protect against leprosy, if it is proved that they do, may be understood when scientists find out the chemical nature of the leprosy germ and also the chemical nature of the vitamins. At that time, also, a specific remedy for the disease may be found or developed. The only remedy used at present, chaulmoogra oil, has not fulfilled all the expectations held for it.—*Science Service*

THE ENERGY FACTOR IN CHEMICAL CHANGES

GUY CLINTON, CENTRAL HIGH SCHOOL, WASHINGTON, D. C.

This paper sets forth the importance of the energy factor in chemical reactions. Certain familiar experiments are cited to show that the tendency of one substance to react with another is measured by the amount of energy set free. It is shown that one factor in the conductivity of solutions is directly dependent upon the amount of the energy change which accompanies the electrolysis of materials. The use of the term polarity is somewhat extended to express the degree of activity which one substance has for another.

A table of the heats of formation of some metal halides is given, and the connection of these heats with the degree of activity of the component elements is noted.

. . . . . .

Of the three outstanding factors in chemical changes, viz., energy level, contact of materials, and catalyzers, the first merits more attention than is given to it in current texts on general chemistry. The mathematical treatment accorded it in works on thermodynamics gives it a reputation of being too difficult to inspire students of chemistry to make an early attempt to understand it. It is hoped that the following presentation may be read with interest even by students in the first year of their course.

When a piece of zinc is put into a solution of copper sulfate and allowed to remain for some time, two important changes will be observed. First the surface will become coated with copper, and second the blue color of the solution will slowly disappear. We explain this by saying that zinc has displaced copper and that zinc sulfate has been formed. The student of physics is taught to observe that this change is accompanied by a flow of electricity. When a plate of copper and a plate of zinc are connected with a voltmeter and then dipped into a solution of copper sulfate, a pressure of about 1.1 volts is shown. In order to show the maximum voltage, the solution should have zinc sulfate in one section of the cell and copper sulfate in the other. The zinc plate is dipped into the former and the copper plate into the latter. By this arrangement copper ions will discharge on the copper plate instead of on the surface of the zinc, and the zinc plate will dissolve, forming more zinc sulfate.

In this experiment the production of electricity is of no less interest than the changes in the substances. How can it be accounted for? By making use of the ionic theory, we frame the reply about as follows: when zinc as a free metal is transformed into zinc ions more energy is released than is required to transform copper ions into free copper, and the surplus flows through the wire as electricity.

Some confirmation for this view may be found by examining heats of formation as found in the international critical tables. It is there shown that the heat of formation of zinc sulfate is 960 kilojoules, while that of copper sulfate is 748. Since the group SO_4 is common to these two sub-

stances, we may properly infer that the difference in these heats of formation is due to the difference in energy necessary to transform Zn to Zn^{++} and that required to change Cu^{++} to Cu.

Let us note the behavior of other metals in solution of salts under parallel conditions. Both zinc and copper will displace silver from $AgNO_3$. What would happen if we place both of these metals in a silver nitrate solution at the same time? Let us examine the heats of formation and from them predict what should occur. The heat of formation of $Zn(NO_3)_2$ (two norms) is 569 kj.; that of $Cu(NO_3)_2$ (two norms) is 303 kj.; and that of $2AgNO_3$ (two norms) is 206 kj. The drop in energy level from Zn to 2Ag is 363 kj.; while that from Cu to 2Ag is 97 kj. These figures show how much more energy is given off in changing Zn to Zn^{++} than is shown when Cu changes to Cu^{++}. This should lead us to anticipate that $Zn(NO_3)_2$ rather than $Cu(NO_3)_2$ would be formed when silver ions are transformed into silver metal. Now when we try the experiment we obtain a clear solution. If $Cu(NO_3)_2$ had been formed, the solution would have been blue. The evidence of the experiment confirms these data, and we infer a general principle:

Among several chemical units in contact with each other, that reaction will take place which will yield the greatest amount of free energy.

Nernst (*1*) was the first to state the fundamentals of this principle. He observed:

> That every metal has a certain solution tension or pressure tending to drive it into solution (*i. e.*, to become ions). The value of this pressure becomes rapidly less as we pass through the series from magnesium to gold.

Van't Hoff (*2*) expressed it as follows:

> The maximum work is a direct, exact measure of the tendency of substances to react with each other.

Heats of formation are very significant data when we wish to anticipate the behavior of substances in chemical reactions. The figures given in the International Critical Tables were obtained partly by experiment and partly by calculation. In most cases the heat of formation is the amount of free energy given off when elements come together to produce a compound. As a rule the energy content of elements is greater than that of the compounds formed by their union. The change is accompanied by the production of heat, light, or electricity. In a comparatively small number of compounds, heat is absorbed during their formation. For example, when acetylene is formed from carbon and hydrogen it absorbs 215.5 kj. That is, its heat of formation is -215.5 kj. or -55.1 cal. When a formula weight of it is burned, just that much more heat is produced than would be given off in burning the same amount of carbon and hydrogen.

The general rule is that free elements are on a higher energy level than their compounds. Like a stored-up liquid energy spills over when the equilibrium is disturbed. This takes place when the temperature of a system containing diverse chemical units is raised to the kindling point. If the quantities are large, a conflagration ensues, and a vast amount of energy is dispersed in the form of heat. Now when we wish to extract elements from their compounds a quantity of energy equal to the heat of formation must be supplied usually as heat or electricity.

We note the influence of this principle in a study of the conductivity of solutions. *Conductivity is a measure of the work done by the current in getting through the solution.* One of the most important factors is the consumption of energy in the transformation of materials. When active metals are set free, the quantity is large, though it is mostly radiated as heat when they react with water. When hydrogen ion is transformed into hydrogen, very little energy is required (*3*); for this reason acids are among the very best conductors. One cannot make a direct comparison between tables of conductivity and heats of formation, because the movements of the ions are hindered more or less by mechanical influences. For instance the more they are hydrated, the larger the mass which must be moved by a unit of attraction. Again the force of diffusion (osmotic pressure) may be directly opposed to the direction required for the best conductivity. Also (*4*), the electrical restraint to which attention has been called by Debye and Hückel would also influence their motion to some extent. It has been shown (*5*) that conductivity cannot be satisfactorily interpreted in terms of the single principle of ionic motion as attempted by Kohlrausch.

When the electric current is passed through a fused dry salt such as sodium chloride and the product is kept away from the air, the energy consumed is largely stored up in the free elements sodium and chlorine; but when the current is passed through an aqueous solution of sodium chloride, the storage of energy is but momentary, for the elements react with water as soon as formed, giving out much heat and yielding compounds on a lower energy level. It is something like pumping water up into a basket to store it.

All changes in energy are capable of doing work; hence work performed is a measure of energy absorbed. Energy changes accompany many phenomena which are not ordinarily classed as chemical. Such are heats of solution, expansion of gases, and osmotic pressure. Any attempt to interpret heats of formation as a measure of chemical activity must take into account the possibility of other causes affecting the amount of heat transformed.

It is highly desirable to have a direct method of expressing the difference in compounds depending upon their heats of formation. Fortunately,

the term polarity is coming into use for that purpose. For many years the terms polar and non-polar have been used to express two classes of compounds as if they were wholly distinct and independent of each other. It is now understood that the differences are by no means absolute but wholly relative. Prof. John Warren Williams of the University of Wis-

		F_2	Cl_2	Br	I
		0	0	0	0
		F^-	Cl^-	Br^-	I^-
		327	166	120	59
H_2	H^+	HF	HCl	HBr	HI
0	0	397	92	36	25
Ag	Ag^+	AgF	$AgCl$	$AgBr$	AgI
0	-104	204	127	100	63
Cu	$\frac{1}{2}Cu^{++}$	CuF_2	$\frac{1}{2}CuCl_2$	$\frac{1}{2}CuBr_2$	$\frac{1}{2}CuI_2$
0	-35	293	108	67	7
Cd	$\frac{1}{2}Cd^{++}$	CdF_2	$\frac{1}{2}CdCl_2$	$\frac{1}{2}CdBr_2$	$\frac{1}{2}CdI_2$
0	37	600	195	159	102
Zn	$\frac{1}{2}Zn^{++}$	$\frac{1}{2}ZnF_2$	$\frac{1}{2}ZnCl_2$	$\frac{1}{2}ZnBr_2$	$\frac{1}{2}ZnI_2$
0	77	403	209	163	104
Mg	$\frac{1}{2}Mg^{++}$	$\frac{1}{2}MgF_2$	$\frac{1}{2}MgCl_2$	$\frac{1}{2}MgBr_2$	$\frac{1}{2}MgI_2$
0	231	552	321	260	182
Li	Li^+	LiF	$LiCl$	$LiBr$	LiI
0	278	609	408	350	334
Na	Na^+	NaF	$NaCl$	$NaBr$	NaI
0	241	570	411	361	291
K	K^+	KF	KCl	KBr	KI
0	252	561	439	394	330
Rb	Rb^+	RbF	$RbCl$	$RbBr$	RbI
0	256	558	439	402	338
Cs	Cs^+	CsF	$CsCl$	$CsBr$	CsI
0	260	552	446	408	351

TABLE OF HEATS OF FORMATION

These data are taken from International Critical Tables. The unit is the kilojoule instead of the usual calorie. When the number of kilojoules is multiplied by 0.239 the product is kilo-calories.

consin in an address before the Washington Section of the American Chemical Society showed that even the so-called non-polar compounds (organic) manifest polarity over a wide range.

It seems logical to link heats of formation with polarity. The electromotive series of elements is a ladder by which the energy levels of the different elements may be judged at a glance. *Polarity may be defined*

as the degree of difference in the energy levels of elements which combine to form a compound. The most polar compound it is possible to make must be composed of cesium at the top of the ladder with fluorine at the bottom. It should have the greatest energy of formation, and would also require the maximum of energy to restore the elements to the free state. Combinations of other elements which come in between will make compounds of less polarity which would require less energy to break them up into the free elements.

The table (page 686) which accompanies this paper gives a remarkable confirmation of the theories expressed herein. If we look at the column headed F_2 and go to the right to I_2, we see that the heats of formation diminish progressively. If we begin with Ag near the top, the heats of formation increase with few exceptions. The heats of formation of CdF_2, RbF, and several lithium compounds appear to be too large, while several copper compounds appear to be too small. Such discrepancies are to be expected and do not disturb the usefulness of the general principle. Indeed they may point the way to new truth in some unexplored field.

It may be properly pointed out that what has been called chemical affinity can be measured and definitely determined in terms of heats of formation. Chemical energy is nothing more than the energy which is inherent in substances. If the energy content of a substance changes in any degree, as when the valence of an ion changes, the effect is immediately seen in its properties.

Literature Cited

(*1*) SMITH'S "Inorganic Chemistry," Revised edition, The Century Co., New York City, **1910,** p. 670.
(*2*) EUCKEN, JETTE, and LAMER, "Physical Chemistry," McGraw-Hill Book Co., Inc., New York City, **1925,** p. 64.
(*3*) See table on page 686.
(*4*) Ref. (*2*), p. 317.
(*5*) CLINTON, "Further Light on the Conductivity of Solutions," The Chemical Publishing Co., Easton, Penna.

Chemical Hobbies. Teachers who are on the look-out for material to aid them in encouraging or guiding their students in the pursuit of chemical hobbies would do well to write for a sample copy of *Rocks and Minerals* (35 cents). This interesting little quarterly, devoted primarily to the interests of the amateur collector, is edited and published by Peter Zodac of Peekskill, New York. Now in its sixth year, it is not and never has been financially self-supporting, we understand. It represents the devotion of the editor and his friends and contributors to a hobby which they find all-absorbing. The format is pleasing, the paper of high quality, the illustrations of exceptional excellence, and the articles very readable.

MAKING POSTERS FOR CHEMISTRY*

E. E. RADEMACHER, NOKOMIS TOWNSHIP HIGH SCHOOL, NOKOMIS, ILLINOIS

The merits of poster making as a means of arousing interest in a subject have been many times discussed in the JOURNAL OF CHEMICAL EDUCATION.** Our experience along this line is presented herewith for whatever value it may be to teachers interested in this type of project.

The pupils of the general chemistry class undertook the task of making posters on the various elements. The subjects were not assigned but were selected by the pupils from a list of titles placed on the bulletin board. In some cases several chose to coöperate in preparing one poster. The material was collected by the individuals from numerous sources. The previous year the science club had collected from over one hundred fifty manufacturing concerns† exhibit materials which included manufactured products from the crude to the finished form, photographs, and literature of all kinds. These materials formed the nucleus around which the posters were made. Local sources of pertinent materials were also exhausted.

A "dummy poster" on ordinary paper was first submitted for approval. In this way the students profited by suggestions made regarding arrangement of material, lettering, drawings, pictures, etc. The final posters were made on beaver board of uniform size, two by three feet, with edges sanded, and the whole painted in a cream color and striped in dark green or black with a striping brush. Several regular laboratory periods were devoted to this work but a considerable portion of the work was done outside the regular class time.

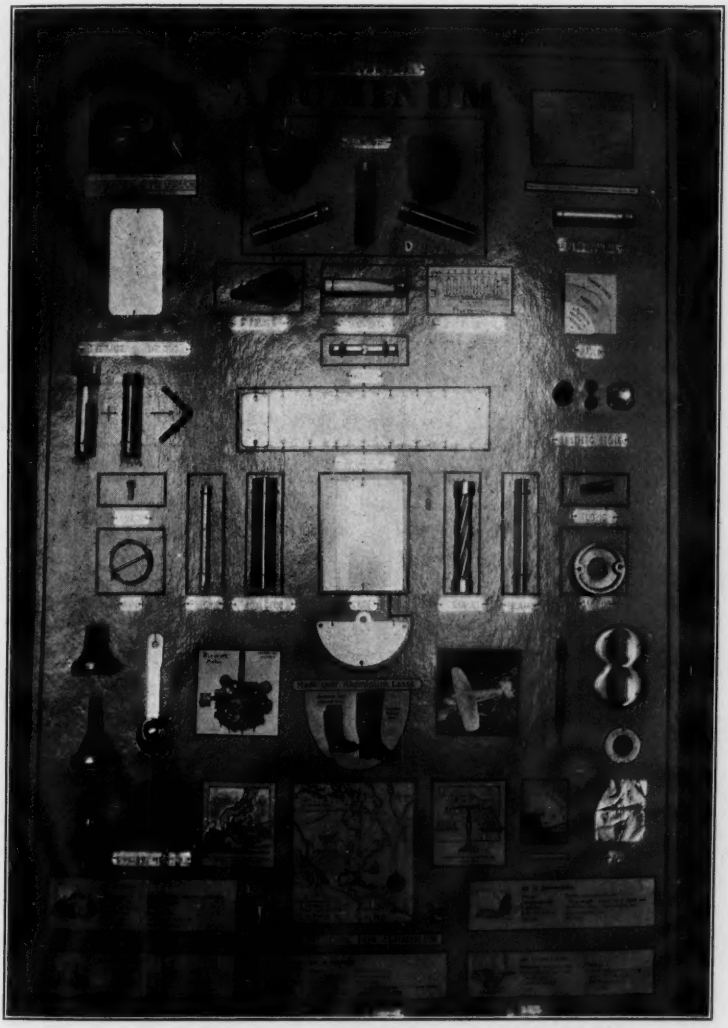
A unique feature of the whole project was the "poster party" held for all students working on posters. This included not only the twenty-four chemistry poster makers but in addition twenty-four biology poster makers. The evening was devoted to hammering, sawing, drawing, painting, lettering, stenciling, pasting, drilling, and typing—a typical factory scene. Refreshments were served.

The success of this poster project is told by the ten selected posters reproduced on the following pages. Each point in these posters was illustrated by the real material, a picture, or a drawing and use of the same. Posters help the pupil who makes them, the teacher who uses them, and the general public who sees them.

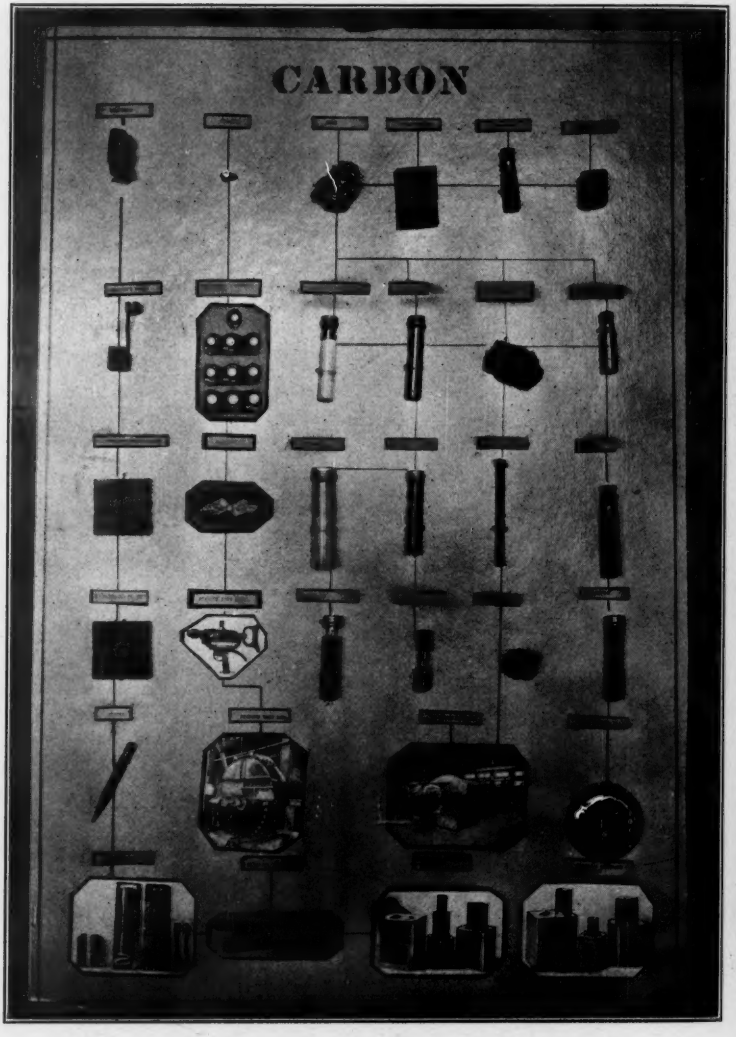
* Presented before the Illinois Association of Chemistry Teachers, November, 1930.

** JACOBS, "Chemical Posters," J. CHEM. EDUC., **2**, 792–4 (Sept., 1925); HAUB, "Students' Research Work in High-School Chemistry," *ibid.*, **4**, 1241–59 (Oct., 1927); BELL, "Posters in Chemistry," *ibid.*, **5**, 157–67 (Feb., 1928); STONE, "Posters in High-School Chemistry," *ibid.*, **6**, 1535–41 (Sept., 1929).

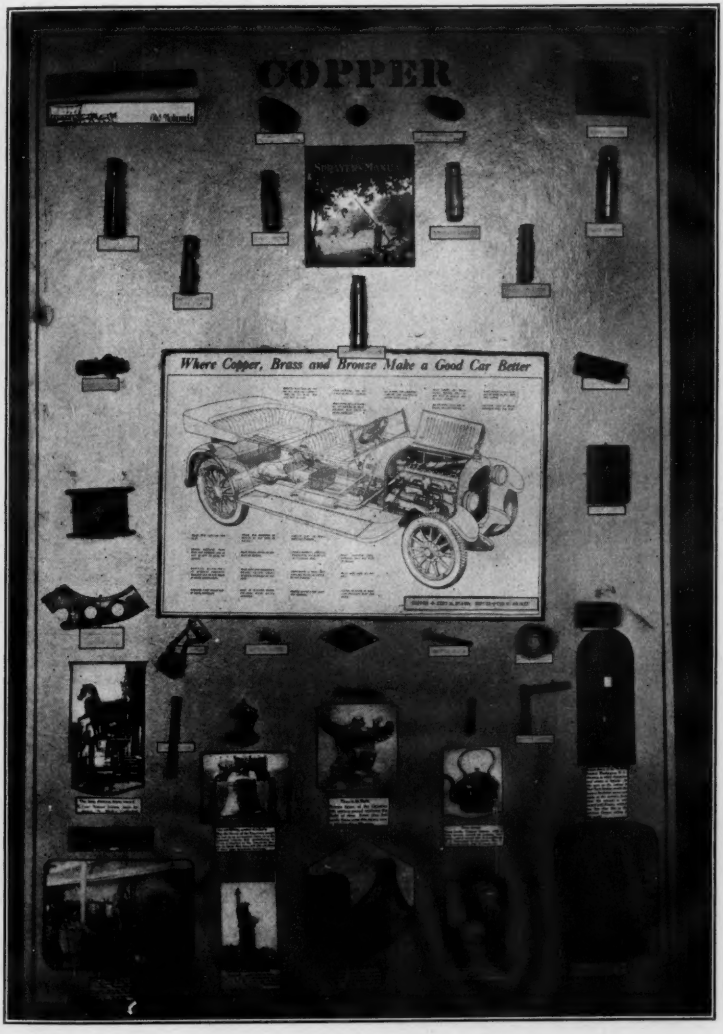
† This list of names and addresses may be obtained from the author for ten cents in stamps to cover cost and mailing.



Sources of aluminum, such as different forms of bauxite, cryolite, alumina; drawing showing electrolysis; picture of the original buttons made by Chas. M. Hall in 1866, photo of Mr. Hall; thermite welding, forging, different grades of metal, uses of such as rivets, molding, radio parts, cables, beams, castings, kitchen utensils, aircraft motors, lasts, airplanes, paints, foils; map showing sources of raw material and plants; wire, synthetic stones, other common and unusual uses.



The forms, diamond, graphite, lampblack; the development of carbon into various uses such as abrasives, drills, cutters, jewels, brushes, lubricants, pencils, reducing agents, electrodes, coal, and some of important derivatives.



Various ores; chart showing parts of car using copper or alloys of copper such as bearings, gaskets, rivets, screws, radiators, gas tanks, oil lines, etc.; other uses of alloys such as bells, brass, coins, statues, cables, halftones, and so on. Compounds of copper, as insecticides, fungicides, and the like.

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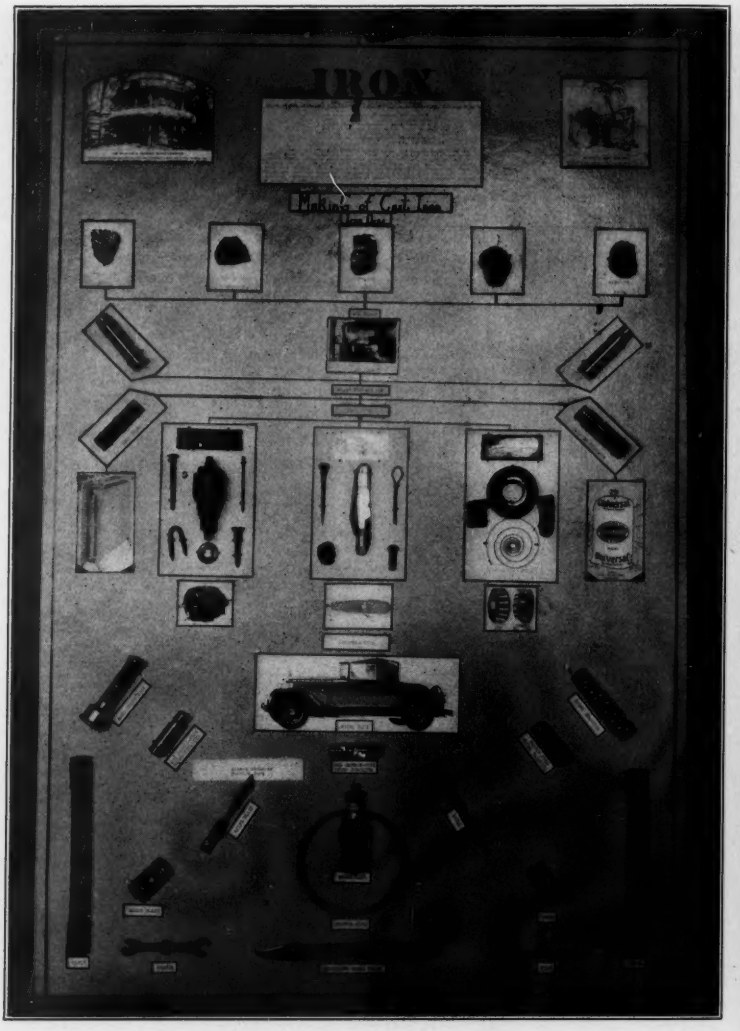
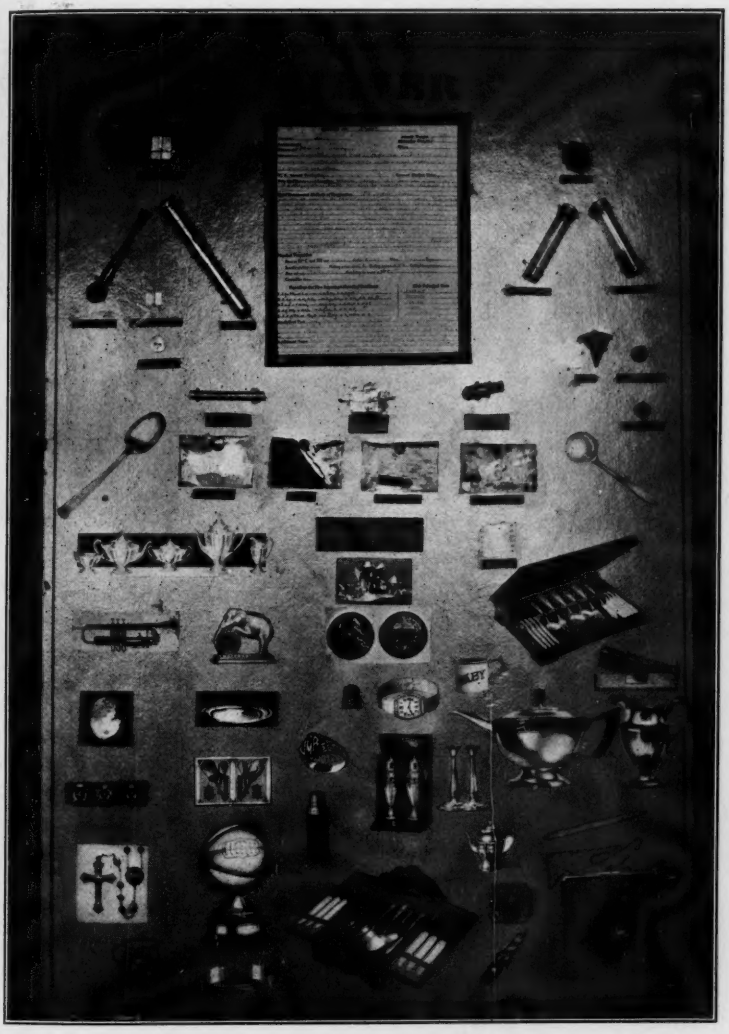
Butler University
LIBRARY



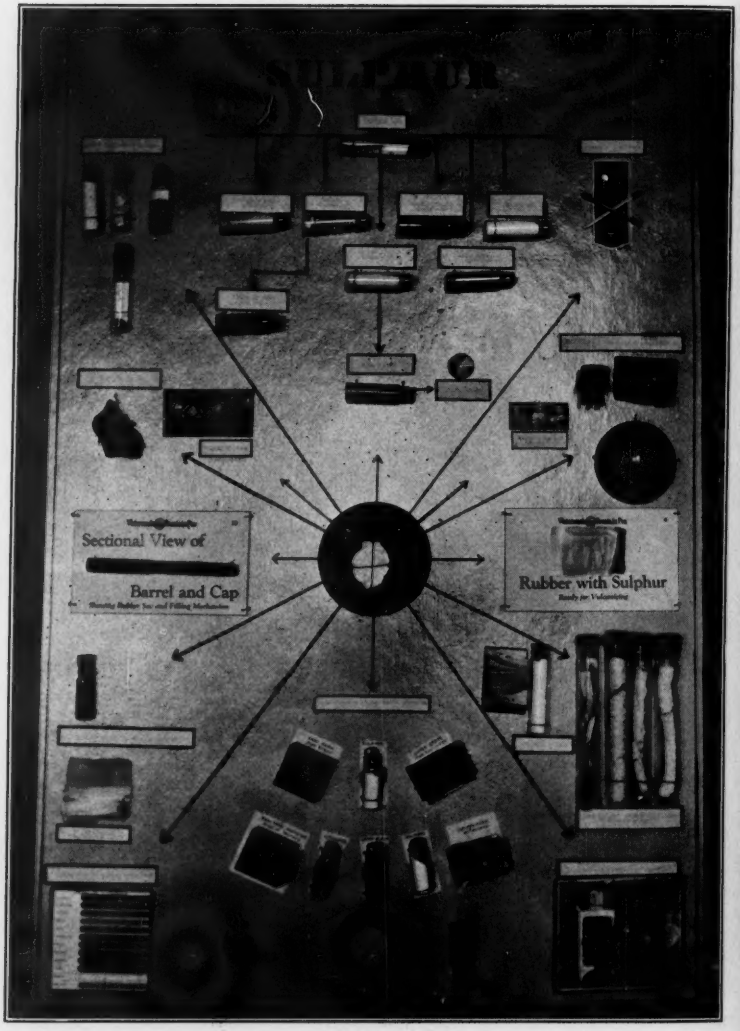
Primitive and modern blast furnaces; making of cast iron showing five ores and lines running from them to show process of manufacture of cast iron, wrought iron, high-carbon steel, and low-carbon steel. A number of finished products of each are shown.

Various ores, and how metal is used in batteries, etc.; how alloys are used as type metal, solder, pewter, fuses, shot, toothpaste tubes, sinkers, foil, and for plumbing purposes; how compounds of lead are used as matches, cut-glass, paint pigments, etc.

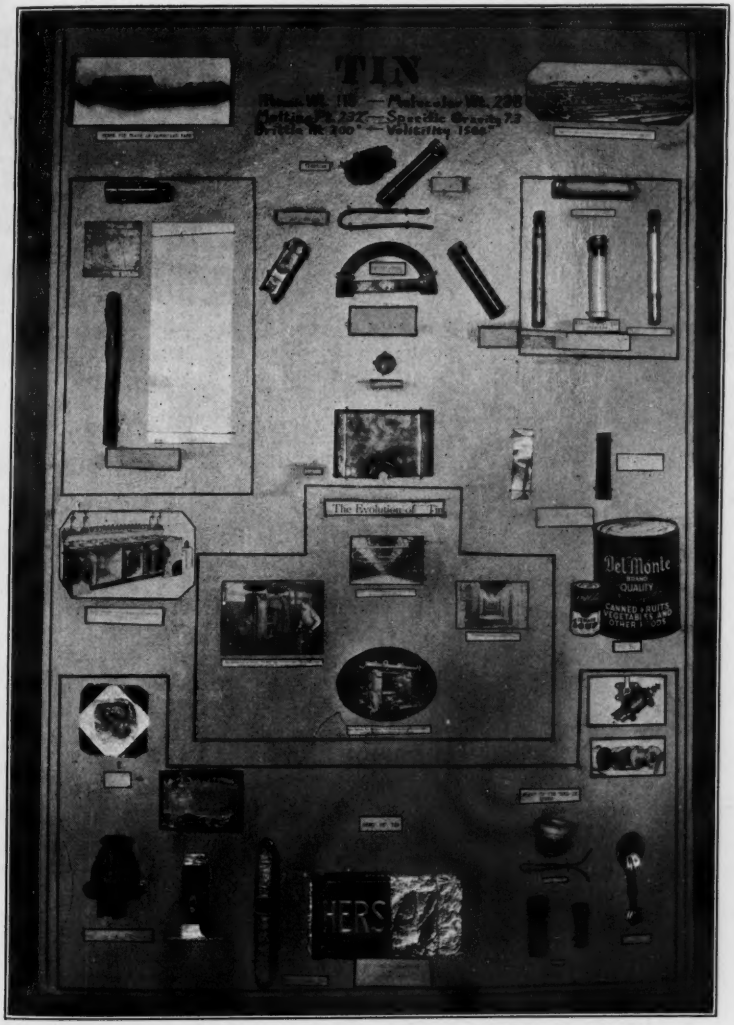
Preparation, occurrence, properties, and compounds of silicon. In the center of this poster is a painting showing a seashore of sand, gravel, and rock; on this shore is pictured a castle built of brick, rock, sandstone, tile, windows, etc., a camping scene showing an enameled kettle, chinaware, etc., and granite mountains are in background. Ingredients in the manufacture of glass are shown in labeled glass vials.



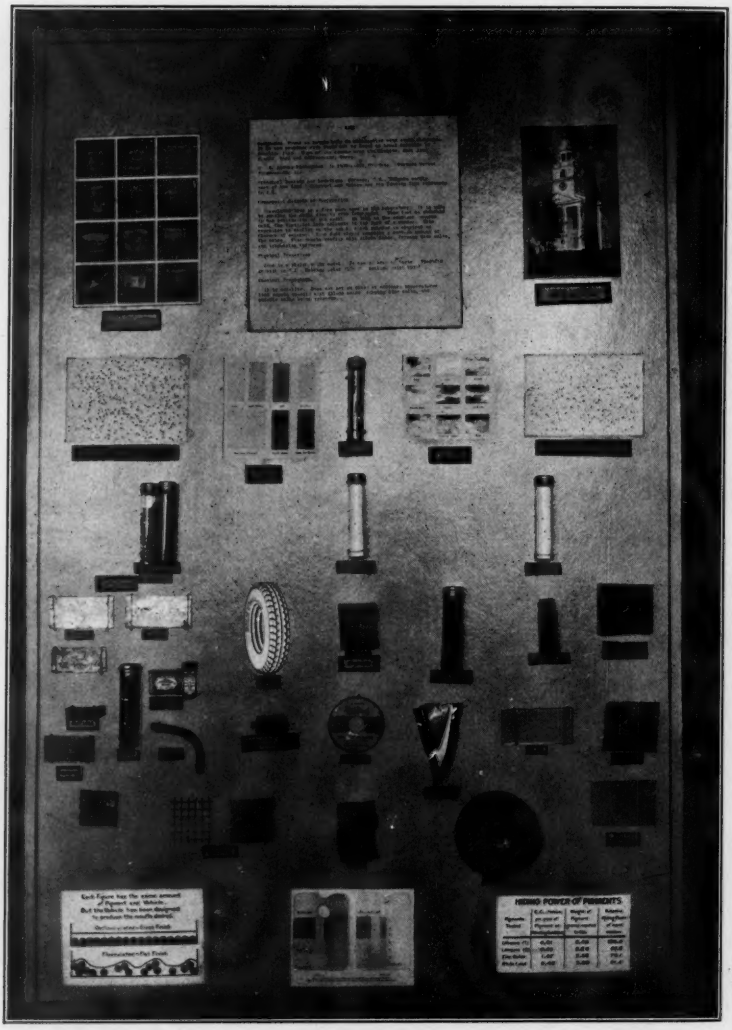
General typewritten report; ore; metallic form showing number of uses such as jewelry, silverware, uses in photography, musical instruments, trophies. As silver products are rather expensive quite a few pictures were used.



A piece of roll sulfur in the center of the board. From this arrows radiate in every direction to the following: different forms of sulfur, matches, sulfuric acid and some of its products, pyrite; sulfur in fruits, radio parts, fountain pens, dyes used in the rubber industry such as in boots, tires, etc.; sprays, bleaching, paper industry, refrigeration, etc.



Where tin plays an important part; picture of the plate factory; ore; evolution of tin; and numerous uses in object form, such as: alloys, foil, cans, and important compounds.



General report on zinc, picture of massive church painted with zinc paint, and paint color chart. Ore; forms of metal and uses such as galvanized iron sheets, nails, screens, fruit jar caps, etchings, batteries, alloys, etc.; compounds of zinc, such as adhesives, linoleum, oilcloth, footwear, glue, glass, celluloid, curtains, tires, pigments, etc.

THE ANALYTICAL DISTILLATION OF GASOLINE

HAROLD J. TORMEY, ST. BONAVENTURE COLLEGE, ST. BONAVENTURE, NEW YORK

The necessary equipment and the procedure for conducting the analytical distillation of gasoline are described and a typical distillation curve is presented. The procedure might well be made the subject of an interesting and informative laboratory exercise. The work might be extended in certain courses in other laboratories as it has in this laboratory, to include a study of the factors affecting the analytical distillation of gasoline. Government specifications of motor and aviation gasoline are included.

. . . . . .

The analytical distillation of gasoline is one of the most important determinations made in the evaluation of light petroleum fractions. Many large users of gasoline, including the United States government, purchase gasoline on specifications and the data obtained by an analytical distillation along with the data obtained from the other determinations usually made indicate whether or not a particular sample meets all requirements.

This determination can be made the subject of an interesting laboratory exercise and especially lends itself to a coöperative experiment with the sheet metal department since the distillation apparatus required could be constructed by that department.

The specifications according to which the distillation apparatus represented in Figure 1 and in photograph on page 701 is constructed may be secured by a request for A. S. T. M. Distillation Apparatus Tentative Standard D-86-26-T addressed to the American Society for Testing Materials, 1315 Spruce St., Philadelphia, Penna. This apparatus may also be purchased from most of the larger supply houses.

The specifications covering the construction of the Modified Bureau of Mines Distillation Apparatus as used by Cosden and Company are given in Figure 2.

Apparatus

In addition to the condenser and cabinet, the following apparatus is required:

1. Standard Engler flask, 100 cc.
2. Standardized thermometer
3. Burner (gas, gasoline, alcohol, or electric heater)
4. Asbestos board 4″ sq. with $1^1/_4$″ hole in center
5. Graduated cylinder, 100 cc.
6. Ring stand, rings, clamps

The specifications covering the flask and thermometer as adopted by Sub-Committee XI of Committee D-I of the American Society for Testing Materials are as follows:

Flask.—The flask used shall be the standard 100-cc. Engler flask described in the various textbooks on petroleum. Its dimensions are:

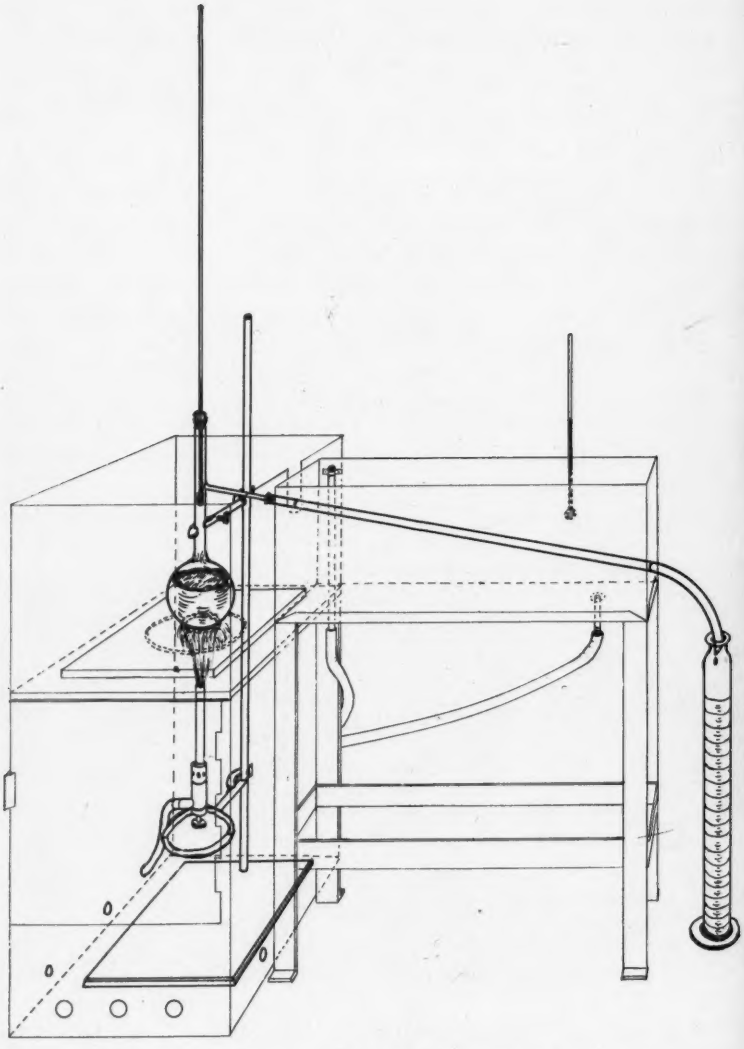
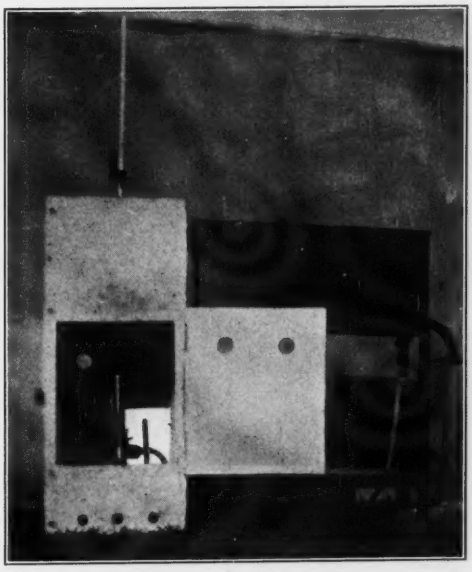


FIGURE 1.—DIAGRAM OF A. S. T. M. DISTILLATION APPARATUS

Outside diameter of bulb	6.5 cm.
Outside diameter of neck	1.6
Length of neck	15.0
Length of vapor tube	10.0
Outside diameter of vapor tube	0.6

Position of the vapor tube 9 cm. above the surface of the gasoline when the flask contains its charge of 100 cc. The tube is approximately in the middle of the neck. The observance of the prescribed dimensions is considered essential to the attainment of uniformity of results. The flask shall be supported on a ring of asbestos having a circular opening, $1^1/_4$" in diameter. Only this limited portion of the flask is to be heated.

Thermometer.—The thermometer shall be made of selected enamel-backed tubing having a diameter between 5.5 and 7 mm. The bulb shall be of Jena normal or Corning normal glass; its diameter shall be less than that of the stem and its length between 10 and 15 mm. The total length of the thermometer shall be approximately 380 mm. The range shall cover 0°C. (32°F.) to 270°C. (518°F.), with the length of the graduated portion between the limits of 210 to 250 mm. The point marking 35°C. shall not be less than 100 mm. or more than 120 mm. from the top of the bulb. The scale shall be graduated for total immersion with an accuracy within 0.5°C. Space above meniscus must be filled with inert gas.



PHOTOGRAPH OF A. S. T. M. DISTILLATION APPARATUS

Both the Engler flask and the standardized thermometer as described above are obtainable from most supply houses.

Procedure and Details of Manipulation

1. The condenser box is filled with water containing a liberal portion of cracked ice.

2. The charge of gasoline (100 cc.) is measured into the clean dry Engler flask from a 100 cc. graduate. The graduate is used to receive the distillate without any drying. This procedure eliminates errors due to incorrect scaling of graduates and also avoids the creation of an apparent distilla-

tion loss due to the impossibility of draining the gasoline entirely from the graduate.

3. The above-mentioned graduate is placed under the lower end of the

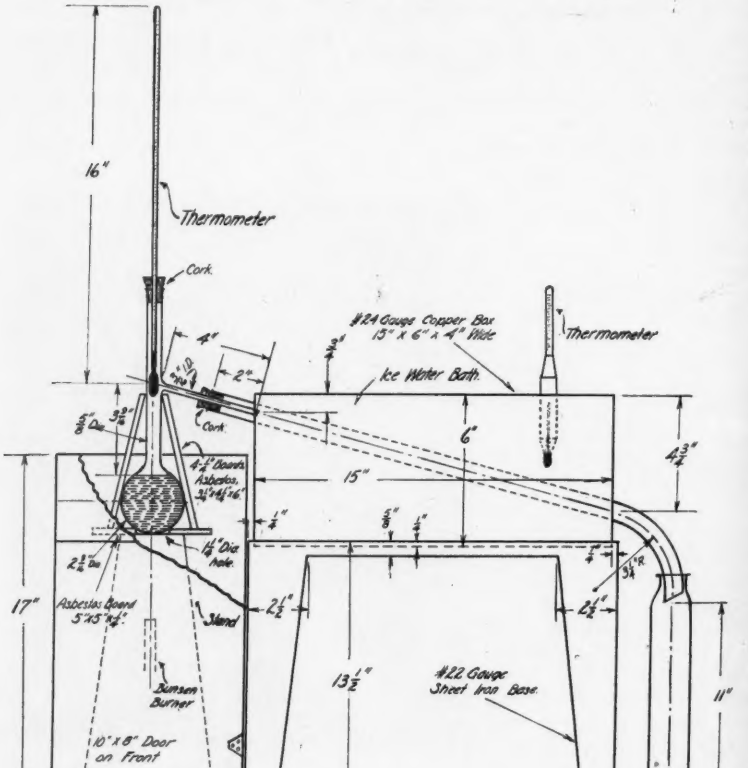


FIGURE 2.—MODIFICATION OF BUREAU OF MINES APPARATUS FOR DISTILLATION AS USED BY COSDEN AND COMPANY

condenser tube so that the latter extends downward below the top of the graduate at least 1 inch. The condenser tube should be so shaped and bent that the tip can touch the wall of the graduate on the side adjacent to the condenser box. This detail permits distillates to run down the side

of the graduate and avoids disturbance of the meniscus caused by the falling of the drops. The graduate is moved occasionally to permit the operator to ascertain that the speed of distillation is right, as indicated by the rate at which drops fall. The proper rate is from 4 to 5 cc. per minute, which is approximately two drops a second. The top of the graduate is covered, preferably by several sheets of filter paper, the condenser tube passing through a snugly fitting opening. This minimizes evaporation losses due to circulation of air through the graduate and also excludes any water that may drip down the outside of the condenser tube on account of condensation on the ice-cooled condenser box.

4. A boiling stone (a bit of unglazed porcelain or a few grains of sand) is dropped into the gasoline in the Engler flask. The thermometer is equipped with a well-fitted cork and its bulb covered with a thin film of absorbent cotton (preferably the long-fibered variety sold for surgical dressing). The thermometer is fitted into the flask with the bulb just below the lower level of the side-neck opening and exactly in the center of the cross-section of the neck of the flask. The flask is connected with the condenser tube.

5. The source of heat in distilling gasoline may be a gas burner, an alcohol lamp, or an electric heater. Heat must be so applied that the first drop of gasoline falls from the end of the condenser tube in not less than five nor more than ten minutes. The initial boiling point or overpoint is the temperature shown by the thermometer when the first drop falls from the end of the condenser tube into the graduate. The operator should not allow himself to be deceived as sometimes (if the condenser tube is not dried from a previous run) a drop will be obtained and it will be some time before a second one falls; in this case the first drop should be ignored. The amount of heat is then increased so that the distillation proceeds at a rate of from 4 to 5 cc. per minute. The thermometer is read for each 5 cc. accumulating in the receiver. The end-point (also called dry point and maximum boiling point) is determined by continuing the heating after the flask bottom has boiled dry, until the column of mercury reaches a maximum and then starts to recede consistently.

6. Distillation loss is determined as follows: the condenser tube is allowed to drain for at least five minutes after the heat is shut off, and a final reading is taken of the quantity of distillate collected in the receiving graduate. The distillation flask is removed from the condenser and thoroughly cooled as soon as it can be handled. The condensed residue is poured into a small graduate or graduated test tube and its volume measured. The sum of its volume and the volume collected in the receiving graduate, subtracted from 100 cc., gives the figure for distillation loss. It is convenient to have students work in groups of four. One student times the rate of distillation and advises a second student who controls

the rate of heating as to whether the rate is satisfactory. If the rate of distillation is reported too slow or too fast the rate of heating is adjusted accordingly. A third student reads the temperature when a fourth student advises him of the overpoint and the accumulation of each five cc. of distillate. A second distillation should be performed on the same sample with a new group of four students. The results of the two distillations should be approximately the same.

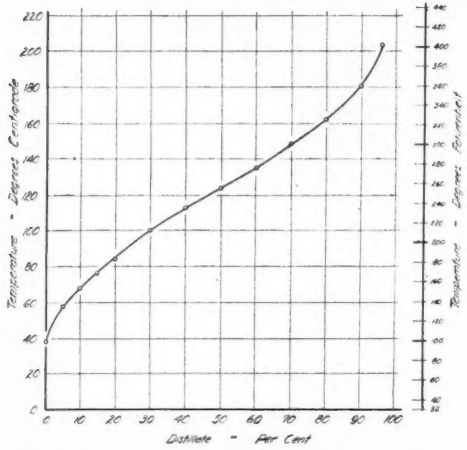


FIGURE 3.—TYPICAL DISTILLATION CURVE FOR GASOLINE

A composite of the distillation curves of fourteen different samples of gasoline.

From the standpoint of volatility motor gasoline may be looked upon as being composed of three portions: (1) a low-boiling volatile portion which is of value in starting, (2) an intermediate portion, and (3) the power portion which is usually considered to be desirable in as large a percentage as can be completely vaporized by the carburetor. By the use of a fractionating column the relative proportions of the above-mentioned portions can be well brought out when the distillation curve is drawn.

The United States government specifications for motor gasoline and aviation gasoline are given in the accompanying table.

U. S. Government Specifications

MOTOR GASOLINE

10%	Minimum	122°F. (50°C.)
	Maximum	176°F. (80°C.)
50%	over, at or below	284°F. (140°C.)
90%	over, at or below	392°F. (200°C.)
End-point not above		437°F. (225°C.)
Recovery (minimum)		95%

AVIATION GASOLINE

Distillation Range

		Fighting Grade	*Domestic Grade*
5%	Minimum	50°C. (122°F.)	50°C. (122°F.)
	Maximum	65°C. (149°F.)	75°C. (167°F.)

		Fighting Grade	*Domestic Grade*
50%	Minimum	.....	.....
	Maximum	95°C. (203°F.)	105°C. (221°F.)
90%	Minimum	.....	.....
	Maximum	125°C. (257°F.)	155°C. (311°F.)
96%	Minimum	.....	.....
	Maximum	150°C. (302°F.)	175°C. (347°F.)
End-Point			
	Maximum	165°C. (329°F.)	190°C. (374°F.)

A composite of the analytical distillation curves of 14 different samples of gasoline as obtained on the market is found in Figure 3.

Army Chemists Developing New Gas-Fighting Equipment. Carefully guarded from the eyes of the curious, the U. S. War Department's chemical warfare service has been concentrating its experimental work in gas offensive on the development of a combination gas-high explosive aerial bomb.

During the World War gas was used with telling effect by the Germans, and toward the close of the war the U. S. Army chemists were pouring deadly fumes into the German defense too. Gas attacks from airplanes, however, are strictly a post-war development.

Army chemists consider the perfection of a bomb which, when dropped from the air will spread a gas blanket over the surrounding terrain to be one of their most important jobs.

Efforts are also being made to cut down the weight of gas masks, and new types which are safer and permit more activity on the part of the wearer are being produced. American gas masks are the best in the world, Major General H. L. Gilchrist, chief of the Chemical Warfare Service, believes, but he thinks that their weight and bulk are "still greater for foot troops than is desirable."

"The development of gas masks suitable for voice transmission for use with optical instruments such as range finders, field glasses, and periscopes is nearing completion," General Gilchrist said. "This mask has a special molded rubber facepiece and is assembled to a canister placed at the back of the head."

Medical attachés to the chemical service are at work, too, officials revealed, on a means of developing a mask which will not give the wearer the headaches experienced by so many soldiers during the last war. Army chemists stoutly assert gas warfare is the most humane type of offensive, and to prove their claims quote from World War statistics to show that gas, while it temporarily disabled an astonishing number of fighters, killed comparatively few.

"A gas casualty has about ten more chances than a high explosive or rifle casualty of coming through whole," Dr. G. A. Rankin, one of the civilian experts employed by the government for gas experimental work, explained.

Dr. Rankin is one of a number of civilians working in government laboratories to develop chemical warfare. He and his associates have concentrated their equipment at Edgewood Arsenal, near Baltimore, and behind guarded doors are working out the methods the chemical warfare service will apply if this country is ever at war again.—*Science Service*

A PRACTICAL HOT-STAGE FOR THE MICROSCOPE

EDWARD H. WALLACE* AND MARY L. WILLARD, THE PENNSYLVANIA STATE COLLEGE, STATE COLLEGE, PENNSYLVANIA

A practical easily built hot-stage has been constructed with which temperatures up to 500° Centigrade are easily obtainable. An accuracy of two- to three-tenths of a degree is the limit of reading permitted by the calibration of the millivoltmeter.

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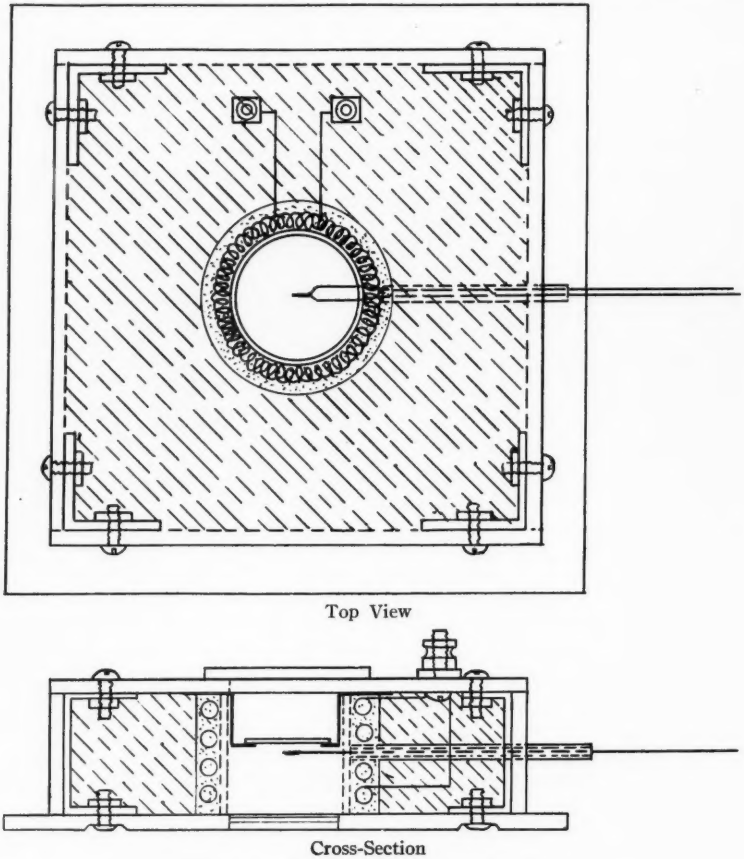
The application of the microscope to the determination of melting points has been a wide and varied field. Most of the work which has been done



Top View

Cross-Section

FIGURE 1.—SECTIONAL DRAWING OF APPARATUS

* From a thesis presented by Edward H. Wallace in fulfilment of the requirements of senior research.

in the development of hot-stages for the microscope has been confined to the special field in which the particular investigator worked (*1*). Use of the hot-stage in his study of rubber fillers is an example of recent specific application. Others who have developed or applied the hot-stage to their problems are Oberhoffer, Cram, Cottrell, Clevenger, and Eitel and Lange (*2*).

Chamot and Mason (*3*) have described the preparation of a hot-stage using "alberene stone and platinum wire coils."

The purpose of this work was to develop a practical, strong and simple heating element which could be easily and quickly built from material usually available in any laboratory, and which would have a wide range of temperature and a certain degree of accuracy.

An upright cylinder was used as the foundation unit of the hot-stage as transmitted light was used. This cylinder was made by sawing with a hack saw an inch section from an alundum crucible.* The heating element was made by winding twenty feet of alumel wire** in the form of a small continuous coil around the alundum cylinder. The coil was held in place by coating the cylinder with a mixture of magnesium oxide and water and baked in an oven at one hundred and ten degrees for three hours.

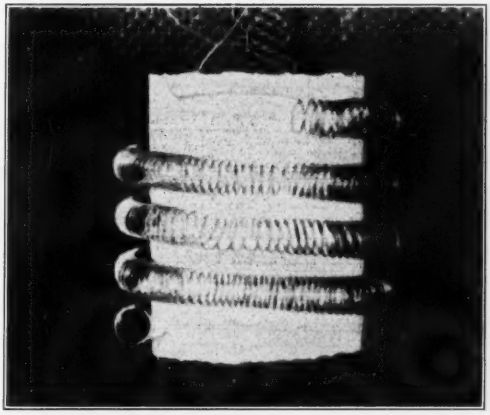


FIGURE 2.—HEATING UNIT

A container in the shape of a box, four by four by one inches, was made for this heating element from asbestos board and small angle irons. A circular opening, three-quarters of an inch in diameter, was made both in the top and bottom of the box so the heating element would fit tightly.

Since a wide range of temperature was to be covered by the hot-stage, it seemed desirable to use a thermocouple (*4*).

Wires of copper and advance metal were used for the couple and a millivoltmeter with a range of thirty millivolts, calibrated in two-tenths millivolts was used for recording the temperature. A Dewar flask containing

* Alundum crucible No. 21290, Eimer & Amend Co., New York City.

** Alumel wire No. 27, Hoskins Mfg. Co., Detroit, Mich.

water was used as a cold junction for the thermocouple and the leads from it were run directly to the meter.

The couple was inserted in the center of the heating element through the side of the alundum crucible. The leads were insulated with a heavy porcelain tube. After the element and the lead wires were adjusted in the container, it was packed with a mixture of asbestos and sodium silicate

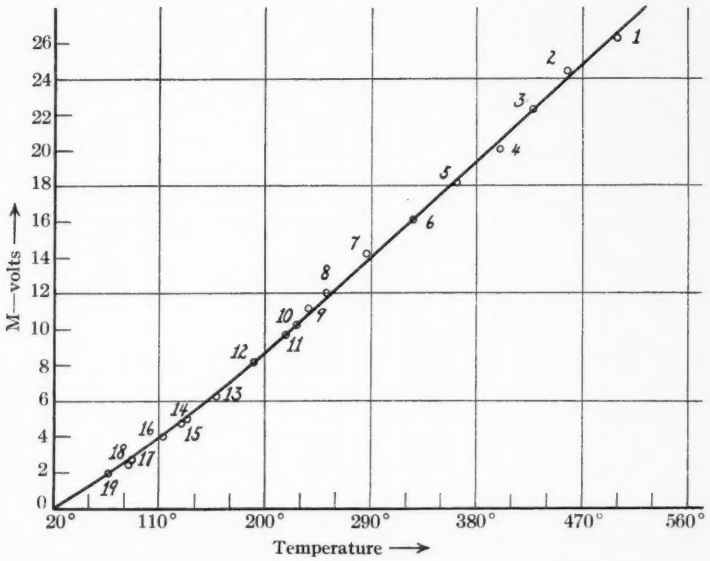


FIGURE 5.—CALIBRATION CURVE

Key to Numbers

1—Lead chloride
2—Silver chloride
3—Silver bromide
4—Potassium dichromate
5—Sodium dichromate
6—Potassium nitrate
7—Anthraquinone
8—Phenolphthalein
9—Caffein
10—Saccharin
11—Phenyl hydrazine hydrochloride
12—Aniline hydrochloride
13—Salicylic acid
14—Pyrogallic acid
15—Urea
16—Acetanilide
17—Vanillin
18—Naphthalene
19—Thymol

and baked in an oven at one hundred and ten degrees for four hours. Supports consisting of thin brass strips were mounted at the top and bent down inside the cylinder about half-way to hold the preparation on a cover slide. A glass disk was mounted in the bottom and a slide placed over the top to keep in the heat. Clear quartz or mica were found to be much better for higher temperatures.

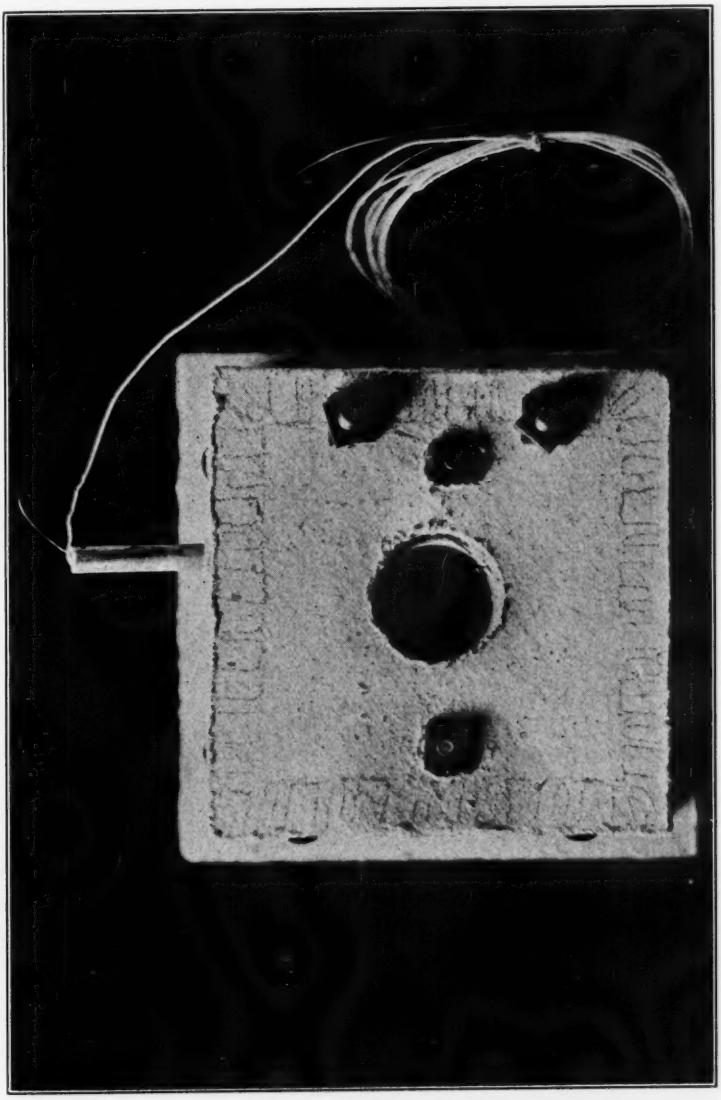


FIGURE 3.—OVEN

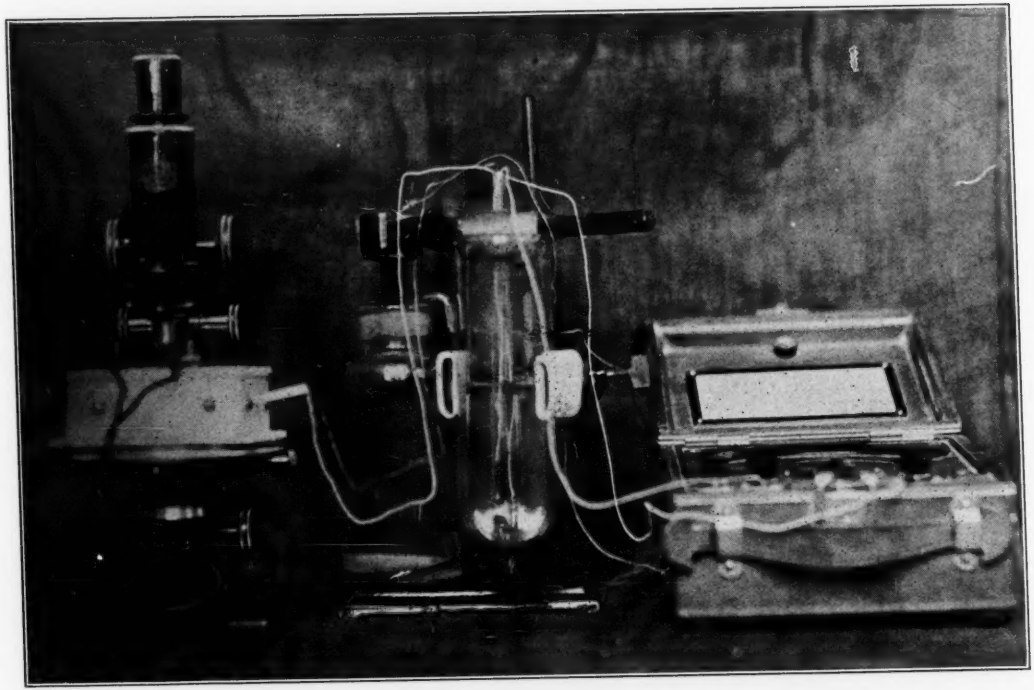


FIGURE 4.—ENTIRE SET-UP

The temperature was controlled by a water rheostat in conjunction with the 110-volt line.

The apparatus was calibrated by determining the melting points of various chemically pure salts of known melting points. A curve was drawn plotting the known melting points against the corresponding readings of the millivoltmeter. In the determination of each melting point, the temperature was increased slowly at a given rate. A camera lucida can be used to read instantaneously the millivoltmeter as the substance melts.

The calibration curve was not a straight line as might have been expected but had a slight change in slope which is accounted for by the fact that there was some conductance of heat along the thermocouple wires into the junction. This did not affect the accuracy of the determination.

Melting points were determined on the following materials as unknowns:

		Melting Point in Literature	*Melting Point as Determined*
1.	Thymol	51.5	51.2
2.	Urea	132.6	132.5
3.	Silver Nitrate	209.0	208.8
4.	Phenolphthalein	261.0	261.1
5.	Potassium Dichromate	397.5	397.5

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(*1*) WALTON, *Ind. Eng. Chem., Analyt. Ed.*, **1**, 106 (April 15, 1929).

(*2*) OBERHOFFER, *Z. Elektrochem.*, **15**, 634 (1909); CRAM, *J. Am. Chem. Soc.*, **34**, 954 (1912); COTTRELL, *ibid.*, **34**, 1328 (1912); CLEVENGER, *Ind. Eng. Chem.*, **16**, 854 (1924); EITEL and LANGE, *Z. anorg. Chem.*, **171**, 168 (1928).

(*3*) CHAMOT and MASON, "Handbook of Chemical Microscopy," vol. 1, John Wiley & Sons, Inc., New York City, **1930**, p. 203.

(*4*) NIETHAMER, *Mikrochemie*, **2** (2), 223 (1930).

United States Civil-Service Examinations for Teachers. The United States Civil-Service Commission announces the following-named open competitive examinations:

TEACHER, SENIOR HIGH SCHOOL (Grades 10–12), $1860 a year, TEACHER, JUNIOR HIGH SCHOOL (Grades 7–9), $1680 a year, TEACHER, INTERMEDIATE (Grades 4–6), $1680 a year, TEACHER, PRIMARY (Grades 1–3), $1680 a year.

Applications for the above-named positions must be on file with the U. S. Civil-Service Commission at Washington, D. C., not later than March 10, 1931.

The examinations are to fill vacancies in the Indian Service.

Competitors will be rated on pedagogy (questions on educational methods, school discipline and administration, history and science of education) and on their education, training, and experience.

Certain specified education and experience is required.

Full information may be obtained from the United States Civil-Service Commission, Washington, D. C., or from the Secretary of the United States Civil-Service Board of Examiners at the post-office or customhouse in any city.

CHEMISTRY IN THE VOCATIONAL HIGH SCHOOLS OF THE MIDDLE WEST*

MABLE SPENCER, GRANITE CITY COMMUNITY HIGH SCHOOL, GRANITE CITY, ILLINOIS

The recognition which chemistry has received from the industries has been reflected in the building of vocational-school curricula. Most vocational schools of the Middle West are offering related chemistry to pupils in all trades where chemical knowledge may be of practical value. The amount of chemistry given varies with the trade, and the method of presentation depends upon the administrative policy of the director. Chemistry, as a trade, has been found to offer boys an opportunity to get worthwhile industrial experience and enough of a knowledge of chemistry to enable them to advance in the chemical world providing they secure further education. The field of vocational chemistry teaching is comparatively new and offers many advantages to the progressive well-educated industrially experienced chemistry teacher.

. . . . . .

The object of this paper is to give briefly the types of chemistry taught in vocational schools. A survey was made of the chemical work taught in the vocational high schools of thirteen states. The results of this survey tend to show that there is a wide range of opinion as to the amount of chemistry which should be offered and as to the method of presentation to be used. All variations in amount were reported from no chemistry to two years of related science, half of which was given to chemistry.

Some directors believe that only the science actually needed to perform the job in hand should be taught. The opinion of Mr. Heilig of Appleton, Wisconsin, represents this extreme. He says,

> The use of the specialized teacher and unit courses in the field of chemistry tends to set up content which is non-functional and cold storage. We tend to lead students to the shrine of the god chemistry and teach the chemistry as an end in itself. We have a naïve wishfulness and hopefulness that the student will somehow carry the drippings from the chemical altar and use them on the job.

As a result he has all related work taught by the shop teacher. Many arguments favor this plan yet the question is often raised as to whether or not the shop teacher has time to teach all of the chemistry which might help the man on the job, were he chemically qualified to do so.

The next step in chemical recognition is the introduction of chemistry into what is known as related or allied science courses. The amount of chemistry given varies with the trade. Some trades have practically no immediate applications of chemistry while others are largely chemical. The least time reported as given to chemistry was three weeks out of a year of science. Some reported as high as one year out of two years of science work. Related science is sometimes taught by the shop teacher and some-

* Presented before the Illinois Association of Chemistry Teachers, November 21, 1930.

times taught by a science teacher. In most cases, during the last half of the course it is directly related to the student's field of major interest. Mr. Harold R. Smith of the Arthur Hill Trade School of Saginaw, Michigan, reports that this method is used in the chemistry course of his school. Chemistry seems to be gradually working its way into the curriculum of the vocational high school. The time may vary from a few odd minutes given it by the shop teacher to a regular two-year industrial chemistry course. The usual time allotted to chemistry in the boy's vocational courses was found to be a year course having five forty-five-minute periods a week. Although chemistry is sometimes thought of as purely a man's course, it has come more rapidly into the home economics and nursing courses than into other fields. In several towns, especially in Texas, there is a tendency to include special courses for people of various industries, either as one-semester evening courses or as short courses. The most common examples are chemistry courses for oil workers and cleaners.

In Granite City we are offering a four-year industrial chemistry course. Any boy who has finished the eighth grade, and has shown an aptitude for science may enter this course. He is given English, mathematics, physics, mechanical drawing, history, citizenship, and hygiene in addition to his chemical work. For the first two years he has four fifty-minute periods of chemistry daily. At the end of this time he is placed in a plant where he works on a two-week coöperative basis; that is, for two weeks he works as a chemist in a plant at the end of which time he returns to school for two weeks of related work.

Course of Study for Industrial Chemists, Community High School, Granite City, Illinois

First Semester	*Second Semester*
Freshman	
English I	English II
Arithmetic I	Arithmetic II
Physiology I	Physiology II
Drawing I	Drawing II
Industrial Chemistry I	Industrial Chemistry II
Sophomore	
English III	English IV
Algebra I	Algebra II
Physics I	Physics II
Sociology	Civics
Industrial Chemistry III	Industrial Chemistry IV
Junior	
English V	English VI
Plane Geometry I	Plane Geometry II
American History I	American History II
Physics III	Physics IV
Industrial Chemistry V	Industrial Chemistry VI

Senior

English VII	English VIII
Electric Shop I	Electric Shop II
Algebra III	Trigonometry I
Drawing III	Drawing IV
Industrial Chemistry VII	Industrial Chemistry VIII

Plant methods are used from the beginning. He is taught to make his own solutions, use an electric oven, the various types of balances, hydrometers, and similar instruments. Calculations are made on the slide-rule and, whenever possible, industrial samples are used. The general order of the course is: general chemistry, quantitative analysis with the simpler parts of qualitative analysis, industrial, and some organic chemistry.

Early in the course the boys are taken through the typical industries of the community, among which are: The General Steel Castings Co.; The American Steel Co., makers of car wheels; the St. Louis Coke and Gas Co., makers of coke, fuel, gas, ammonium sulfate, and pig iron; The Swift Packing Co.; the Roxana Oil Co.; and the Owen Illinois Glass Co. In visiting these plants the boys see chemistry at work. They are encouraged to read chemical literature. Copies of such chemical magazines as *Chemical and Metallurgical Engineering, Industrial and Engineering Chemistry*, and JOURNAL OF CHEMICAL EDUCATION are always accessible.

Current charts of various kinds are used on the walls of the room. The periodic table, handbooks (the two found most helpful are Van Nostrand and the Chemical Rubber Co.), Treadwell and Hall's "Analytical Chemistry" in volumes I and II, and Roger's "Industrial Chemistry" are frequently used by the students. Once each week the student is required to write a theme on a chemical subject of his own choosing. The purpose of this theme is to enable the student to express chemical information in a clear and interesting manner.

Probably the greatest difference in the regular vocational and the academic courses lies in the method of instruction. The vocational program is built upon the fact that each boy learns to manipulate and to reason. He then progresses at his own rate. This is known as job-sheet method. No student is recommended for a position until the shop instructor is satisfied that the boy is fitted for the work which will be required in this position, regardless of the amount of time spent in preparation. The average student spends twenty fifty-minute periods a week for four semesters.

The general theories of indicators and oxidizing and reducing solutions are stressed, because the student will meet with new conditions in his industrial experiences. In our community, and in all chemically industrial communities, the range of chemistry is very wide and the changes taking place make it impossible for the instructor to predict the exact chemical

situation which the boy will encounter. Specialized courses are avoided. A broad chemical acquaintance with literature and other sources of information are encouraged. Every possible opportunity is used to point out to the boy that the top of the chemical ladder reaches far above the high school or even the college, but it takes work and ability to succeed in this line.

The student is given many opportunities to use his chemical knowledge in his related work. The English reading list includes worthwhile chemistry books. The mathematics course includes problems which a chemist must solve. He draws flow sheets, chemical equipment, and plots chemical data in mechanical drawing. Every opportunity is given him to observe that these and other subjects will aid him in being a successful chemist.

Social advantages are offered to every boy because we realize that the ability to mingle agreeably with others is a necessary asset in the life of any successful citizen. Our opportunities for social training are developed largely through an active science club to which any boy is eligible. He must contribute something in the way of service to the club in order to maintain his membership. We believe that through this service he tends to develop social poise and leadership, because he has an opportunity to choose the thing he is best able to do.

We do not pretend to make chemical engineers of students but we believe they have a basis for doing good constructive chemical work, an understanding of the chemical processes of the industries of the community, skill in handling the tools of their vocation, and a desire to go further in the chosen field of work.

To the well-educated and industrially experienced chemistry teacher, the vocational field offers many opportunities. He meets new and interesting chemical problems daily which he must solve. His opportunity to meet chemists who are accomplishing things keeps him "up on his toes" every minute. The industrial chemistry teacher teaches eight periods a day. The financial opportunities are perhaps greater than those of the average academic teacher. Usually the vocational teacher has eleven or twelve months of work during the year. Since the government refunds part of his salary he may often receive a higher monthly salary than does the academic teacher. However, he must carefully analyze his course of study so that it includes the fundamental chemistry and the chemistry of the community, and job sheets must be written to cover these units. From these facts it may be seen that only a thoroughly trained chemist with some industrial experience could accomplish this task without superhuman effort.

Industrial chemistry gives both student and teacher satisfaction only in proportion to the energy expended.

Acknowledgment

The writer wishes to express appreciation for the help given to her by the following state vocational supervisors.

MISS LIZZIE M. BARBOUR, Assistant Supervisor of Industrial Education of Texas; MR. H. C. THAYER, State Supervisor Vocational Teacher Training of Wisconsin; MR. SCOTT J. MCGINNIS, State Supervisor Trade and Industrial Education, Oklahoma; MR. GEORGE K. WELLS, State Supervisor of Industrial Education of Indiana; MR. H. W. CARMICHAEL, Supervisor Trade and Industrial Education of Iowa; MR. C. M. MILLER, Supervisor of Trade and Industries of Kansas; and MR. K. WILSON, Supervisor of Vocational Education of Michigan.

The following teachers gave assistance in this survey and through them our data were obtained. MR. A. R. GRAHAM, Director Madison Vocational School, Madison, Wisconsin; MR. H. O. EIKEN, Director Vocational School, Green Bay, Wisconsin; MR. FRED G. ERNEY, Evening Chemistry Instructor, Dallas, Texas; MR. HERB HERLIG, Director Appleton Vocational School, Appleton, Wisconsin; MR. HAROLD R. SMITH, Instructor of Chemistry, Arthur Hill Trade School, Saginaw, Michigan; MR. H. R. WILSON, Instructor of Industrial Science, Lansing, Michigan.

The Research Committee of the Illinois Association of Chemistry Teachers presents this report of the Survey of Chemistry in the Vocational High Schools of the Middle West.

J. C. CHIDDIX, *Chairman*, DORR SIMER, ROSALIE M. PARR, MABLE SPENCER.

Science Teachers Warned against Pampering Students. Are even advanced science courses in danger of becoming mere modern substitutes for the old-time Chautauqua lectures?

Teachers of American colleges were challenged by this question recently by Prof. William A. Riley of the University of Minnesota, retiring vice president of the Zoölogy section of the American Association for the Advancement of Science meeting in Cleveland.

"There can be no doubt that today the dominant conception has become one of an unbroken system from the kindergarten to the graduate school, and already there are demands that its requirements and standards be adjusted to accommodate the hordes who must have a doctor's degree in order to obtain or hold a position in our colleges," said Prof. Riley.

"A recent writer has expressed clearly his own and a common opinion when he says, 'The outside citizens are the ultimate deciders of school policies, they hold the purse strings, they own the schools. Educators are their employees.'"

The tendency to supplant laboratory demonstration by textbook instruction was one feature of the new science teaching methods criticized by Prof. Riley. Too often, in his opinion, instead of performing experiments, the modern college student is the subject of experiments by the teacher.

"There are a few groups of peoples which have been more or less tacitly regarded as legitimate experimenting material—condemned criminals, subject nations, and men under rigid military discipline," said Prof. Riley.

"College students are now being added to this list but the teacher who regards his students in that light is no more able to do his best for them than is the doctor whose first concern in meeting his patients is the study of the action of some particular drug."—*Science Service*

MINUTES OF THE MID-WINTER MEETING OF THE EXECUTIVE COMMITTEE OF THE DIVISION OF CHEMICAL EDUCATION OF THE A. C. S.

The meeting was called to order by the Chairman of the Division at 10.00 A.M., January 2nd, in New York City.

Present: J. N. SWAN, *Chairman;* M. V. MCGILL, *Vice-Chairman;* R. A. BAKER, *Secretary;* ROSALIE M. PARR, *Treasurer;* WILHELM SEGERBLOM, *Past-Chairman;* and NEIL E. GORDON, *Editor-in-Chief.*

Reports of Officers

1. Chairman: The *Chairman* reviewed the committee appointments which he had made since the last meeting, each of which has been duly recorded in the list of committees published regularly in the JOURNAL OF CHEMICAL EDUCATION.

2. Secretary: The *Secretary* reported the transfer of the Division files from Syracuse and the installation of the office in the City College building at 17 Lexington Avenue, New York, N. Y. Stationery has been supplied as requested to each committee chairman. Contacts have been maintained with each Local Section of the A. C. S. or Teachers' Association which is represented in the Senate of Chemical Education. A campaign for additional members is under way. On December 31, 1930, there were 267 active and 650 associate members. Tentative plans for the Indianapolis meeting were presented for approval. (See under "Contemporary News" in the January and March issues of THIS JOURNAL.)

The *Secretary* reported the ratification of the selection by the Contributing Editors of NEIL E. GORDON to succeed himself as Editor-in-Chief for a period of three years beginning July 1, 1931. A letter of acceptance was received from Dr. Gordon under date of December 17, 1930.

The report of the *Secretary* was approved.

3. Treasurer: The *Treasurer* presented the following report, covering the period from January 1 to December 31, 1930.

Receipts:	
Memberships	$175.00
Refund from JOURNAL OF CHEMICAL EDUCATION	6.90
Gift from The Chemical Foundation, Inc.	3000.00
Total receipts	$3181.90
.....	
Expenditures:	
(1) Payment of deficit for 1929	
Secretary's Office	$67.33
Committee on Professional Spirit	41.03
Committee on Order of Presentation	5.00

(2)	Secretary's Office (1930)	
	Secretarial assistance	1401.55
	Stamps, telephone, telegraph	216.48
	Office supplies	542.12
	Miscellaneous	69.82
(3)	Treasurer's Office	4.20
(4)	Meetings	512.05
(5)	Committees	
	Naming and Scope of Committees	20.00
	Preparation of High-School Chemistry Teachers	10.00
	Visual Aids	98.73
	Professional Spirit	36.16
	Education by Radio	50.00
	Minimum Equipment	26.46
	Libraries	25.00
	Non-Collegiate Education	12.50
(6)	JOURNAL Reprints	73.25
		$3211.68
	Deficit	29.78
		$3181.90

The report was approved.

4. Editor-in-Chief: The *Editor-in-Chief* reported that the JOURNAL is progressing smoothly. Its most recent development is the section "Contemporary News in Chemistry and Education," which has been substituted in the January, 1931, issue for the Local Activities section. With the exception of the change in title, the only difference in material to be included in this section is that news of general interest to all readers will be published, and items of a purely local character will be eliminated. The change has been made due to the evident opinion of subscribers, as expressed through a recent questionnaire on the JOURNAL, that local news has little value for readers in general.

The report was accepted.

5. Business Manager: The *Business Manager* reported that on December 27, 1930, there were 8943 subscribers to the JOURNAL OF CHEMICAL EDUCATION and 10,501 subscribers to *The Chemistry Leaflet.*

The following classification of JOURNAL subscribers is based directly upon returns received from the subscribers themselves:

Army Officers	7	Chemistry Students	2484
Associations	6	Chemistry Teachers	1894
Assts. to Pres. of Companies	2	Clerk in Bd. of Education	1
Bank Officials	2	Clerk in High School	1
Boards of Education	84	Clubs	2
Chemical Engineers	16	Colleges	108
Chemists	97	College Chemistry Depts.	38

College Libraries	446	Micro-Ballistician	1
College Science Depts.	4	Miscellaneous	1505
College Reading Rooms	2	Museum	1
Companies	115	Nurse	1
Consulting Chemists	8	Pharmacologist	1
Consulting Engineers	5	Presidents of Colleges	5
Deans of Colleges	7	Presidents of Companies	10
Dentists	7	Principals of High Schools	40
Directors of Companies	4	Public Accountants	2
Directors of Laboratories	2	Publications	43
Doctors	94	Public Libraries	58
Doctors of Philosophy	2	Public Schools	13
Druggists	8	Public School Libraries	6
Editors	5	Research Chemists	46
Engineers	10	Sanitary Engineer	1
Entomologist	1	Sanatoriums	2
General Industrial Agent	1	Science Students	31
General Managers of Co.	3	Science Teachers	79
Government Departments	7	Secretaries of Board of Education.	2
Government Officials	3	Societies	2
High-Schools	359	Storekeeper of Company	1
High-School Chemistry Depts.	37	Supt. of Public Schools	5
High-School Libraries	233	Supt. of Schools	30
High-School Science Depts.	30	Supv. Princ. of Board of Educ.	3
Horticulturist	1	Teachers	343
Hospital	1	Technician	1
Insurance Agents	3	Vice Pres. of Companies	10
Laboratories	10	U. S. Possessions and Foreign Subscriptions Not Classified	534
Lawyers	10		
Mechanical Engineers	2		
Merchants	4	Total Subscriptions	8943
Metallurgist	1		

Secretary's Note: The above list includes 2351 copies of the JOURNAL which are sent as group subscriptions to students in 66 institutions. Since a number of these classifications obviously include chemistry teachers, the following have been arbitrarily amalgamated: Boards of Education, Chemistry Teachers, Clerk in Bd. of Education, Clerk in High School, Clubs, Colleges, College Chemistry Depts., College Libraries, College Science Depts., College Reading Rooms, Deans of Colleges, High Schools, High-School Chemistry Depts., High-School Libraries, High-School Science Depts., Principals of High Schools, Public Schools, Public School Libraries, Science Teachers, Secretaries of Board of Education, Supts. of Public Schools, Supts. of Schools, Supv. Princ. of Board of Education, Teachers.

If we assume that these regrouped classifications are teachers and that a fair proportion of the 2681 "miscellaneous" and foreign subscribers are also teachers, it seems safe to say that not less than 4000 JOURNALS reach teachers directly. Of these about 2500 are in secondary schools and 1500 are in colleges and universities.

The financial statement of the *Business Manager* will be published in an early issue of THIS JOURNAL.

Reports of Committees

1. Naming and Scope of Committees: WILHELM SEGERBLOM, *chairman*, presented the following report which was approved.

A letter was recently sent to members of our committee explaining the new procedure for bringing new committees into being as authorized at the Cincinnati meeting of the Executive Committee. According to this procedure, (*a*) our committee will report its findings to the Executive Committee; (*b*) the Executive Committee will act on the report, and (*c*) the Chairman of the Division will thereafter appoint such committees as are authorized. Attached to this letter were copies of the sheets containing data of help to the two new committees—"Teaching Load" and "Examinations and Tests." Copies of this letter and of these data sheets were distributed to the Executive Committee members for their files.

In compliance with the request of Chairman Swan, the data sheet for the committee on Examinations and Tests has been sent to Dr. O. M. Smith, the chairman of the committee.

In regard to a possible member of the committee on Teaching Load for Chemistry Teachers, the question has come up of having non-members of the A. C. S. on Division committees. Our committee is of the opinion that members of our committees should be members of the A. C. S., and that only under very exceptional circumstances (as *e. g.*, Dr. Hale's committee) should non-members be considered eligible.

At the request of Chairman Swan the names of three New England men have been suggested from which to choose one to add to Dr. Hopkins' committee on Teacher Exchange.

Our committee is of the opinion that it is not wise to elect as a chairman of the Committee on Visual Aids any person who is connected with an industrial concern manufacturing visual aids.

2. Visual Aids in Chemical Education: M. V. MCGILL, *chairman*, presented the following report which was approved.

The work which the Committee on Visual Aids in Chemical Education has done during 1930 speaks for itself in the five articles which have appeared in the JOURNAL OF CHEMICAL EDUCATION.* We hear much in this day about capitalizing the fact that students are eye-minded, but the study of visual aids in chemistry this year has shown that there is not an abundance of material available which can be used to advantage in classroom time. Two reasons apparently can be assigned for this, first the fact that most of the material available is produced by industrial concerns who film much material that is interesting, but cannot be classed as chemistry; second, not enough schools can afford to rent and buy pictures of the type which would bring out the chemical features with a minimum time element to make them a profitable investment for producers. However, there seems to be a willingness on the part of coöperating agencies, particularly those producing slides, to make available this material, if particular needs and definite phases of the work can be brought to their attention.

* "Visual Aids in Chemical Education. I," J. CHEM. EDUC., **7**, 828–33 (Apr., 1930); "II. The Program of the Committee on Visual Aids in Chemical Education with Reference to Exhibits," *ibid.*, **7**, 1113–4 (May, 1930); "III. Minimum Equipment for Visual Education in Secondary Schools," *ibid.*, **7**, 1341–8 (June, 1930); "IV. Films Available for Use in Chemistry Classes," *ibid.*, **7**, 2916–27 (Dec., 1930); "V. Slides Available for Use in Chemistry Classes," *ibid.*, **8**, 128–32 (Jan., 1931).

It is needless to say that some schools have long been users of visual materials of one kind or another. But many have no conception of the possibilities in this field. Even to many of those schools which have a moving-picture machine, a definite schedule of pictures is impossible because of the use of the auditorium as a place to study. But to the majority it is probably a case of never having done it and not knowing how or having the inclination to start.

Of the original plans of the Committee, a few did not materialize:

1. We had hoped to put on an exhibit of visual aid material at the Cincinnati meeting of the A. C. S., but requests to various organizations and to teachers through the JOURNAL brought practically no response.

2. A study of motion pictures in two schools where the pictures were shown during class time was not complete enough to consider conclusive, but did bring out the following facts: first, it is very difficult to continually book films to fit in with the subject matter of the lesson at the time it is wanted; second, about one-half of the material is irrelevant so far as its chemical teaching value is concerned; third, in a school where there are several sections, and where the cost per student would seem immaterial, mechanical difficulties arise; fourth, filling out courtesy cards for companies is too easily overlooked; fifth, to be really effective, the teacher must go through and study films before class so as to supplement explanations or be ready to answer and ask questions; and sixth, since the advent of the "talkies," the older style movies are not so popular.

3. Another aim of the committee had been to assemble a list of sources of industrial concerns which were willing to furnish illustrative material, samples of their products, etc., but considerable correspondence shows that the large majority of companies either were flatly opposed to having their name listed or said they had no products for distribution. A few were very bitter in their feeling toward teachers who ask students to write in for material and displays. It seemed best to carry this report over to another year.

The following recommendations are made for the year 1931:

1. The list of visual aid materials, published in the December, 1930, and January, 1931, issues of the JOURNAL should be revised, corrected, and added to each year, appearing in the September issue of the JOURNAL.

2. An impartial study of motion-picture equipment and slide projectors should be made, bringing definite suggestions to schools of various size and financial standing as to equipment available for their particular needs.

3. An effort should be made to obtain from chemistry teachers definite chemical facts, theories, fundamentals, and processes that need to be developed from the visual standpoint, and then put these facts up to producers of various types of visual aids.

4. It would seem advisable to devote a half day at the Buffalo meeting of the A. C. S. next fall to the subject of Visual Aids.

3. Chemical Education of the Non-Collegiate Type: R. E. BOWMAN, *chairman*, transmitted a progress report by letter which was accepted.

4. Chemical Education by Radio: R. F. MCCRACKAN, *chairman*, wrote that he had conferred in Washington, D. C., with Mr. Levering Tyson, Chairman of the National Advisory Committee on Education by Radio. It was agreed that chemists and other scientists must be fully prepared, when occasion arises, to furnish speakers and subject matter for hook-ups of whole chains.

It seems that we may assume as a working proposition that the radio managers are as anxious as the scientists to have several hours a week given systematically to educa-

tion in the sciences, and that plans should be laid for several years at a time instead of for one only, and that a plan to remunerate speakers should be worked out. We intend to have an extensive correspondence with the chemists of the country trying to find men best suited to compose talks on chemistry and to deliver them, both for single stations and for hook-ups. And we shall try to know the prevailing sentiment of chemists in regard to the true value of education in chemistry by radio. We shall continue to collect books, papers, and clippings relating to our field.

5. Chemistry Clubs: M. V. MCGILL, *chairman*, reported as follows:

The good work started by *The Chemistry Leaflet* shall be continued by making the *Leaflet* the official organ of Chemistry Clubs. Each issue might well include a chemistry club exchange of ideas; detailed descriptions of workable demonstration experiments for club programs; contests between clubs; etc. Each Local Section of the A. C. S. should be urged to have a "Chemistry Club Night" as one of the features of its regular program.

The report was accepted.

6. Chemistry Libraries: RUFUS D. REED, *chairman*, presented a progress report by letter which was accepted.

This committee proposes to survey the various fields of chemistry with the help of authorities in each field, and to prepare separate work lists, giving titles, authors, publishers, cost, copyright date, and other significant information.

The Executive Committee recommended the inclusion of a few lines of description after any title which was not entirely clear.

7. Correlation of High-School and College Chemistry: NEIL E. GORDON, *chairman*, presented a progress report which was accepted.

Letters requesting opinions on the correlation outline have been sent out to representatives of high schools and colleges in all the states, and criticisms are now being received. A report of the results will be made at the Indianapolis meeting.

8. Labels: JOHN M. MICHENER, *chairman*, presented by letter a progress report which was accepted.

This committee plans to distribute for criticism copies of its last report [J. CHEM. EDUC., **7**, 2937–42 (Dec., 1930)] containing the list of proposed labels. After the final revision has been made, the committee will work to secure its adoption by publishers of label books.

9. Major Topic Organization of High-School Chemistry: HARRY A. CARPENTER, *chairman*, presented a progress report by letter which was accepted.

Secretary's Note: The chairman of this committee is planning a rather extensive trip during the spring of 1931 which will enable him to visit a large number of schools. It is his intention to discuss with as many chemistry teachers as possible the plan which he is promoting in the Rochester, New York, school system.

10. Minimum Equipment for High-School Chemistry: J. H. JENSEN, *chairman*, reported by letter that lists of minimum equipment and chemi-

cals for use by the individual pupil are now ready to be submitted to the Senate of Chemical Education for suggestions as to quantity, grade, etc.

11. Preparation of High-School Chemistry Teachers: A. J. CURRIER, *chairman*, presented by letter the following report which was accepted:

The report presented as a part of the "Symposium on Teacher Training" at the Cincinnati meeting has been extended and was published in the JOURNAL OF CHEMICAL EDUCATION [CURRIER, "The Sectioning Problem in General Chemistry," J. CHEM. EDUC., **8**, 328–30 (Feb., 1931)]. It shows the present unsatisfactory situation very clearly and suggests means for improvement.

We expect to send reprints of the report with a request for careful consideration of the name to the accrediting agencies, the state departments of education, and the secretaries of the local sections of the American Chemical Society.

The committee has made a thorough study of the problem and is presenting its findings with recommendations to the responsible agencies. The responsibility therefore rests upon them in the way of modification of present requirements for the training and certification of chemistry teachers. With this accomplished, it would seem that the purpose of the committee has been fulfilled. We recommend therefore that the committee be discontinued upon presentation of its final report at the spring meeting of the American Chemical Society.

12. Teacher Exchange: B. S. HOPKINS, *chairman*, reported as follows, by letter:

We have thought best to organize on a semi-geographical basis. Each member of the committee is expected to secure the active coöperation of teachers in his part of the country. In this way we hope to be able to arrange an exchange of positions which will be mutually helpful to those concerned. Our greatest problem now seems to be to secure the coöperation of teachers throughout the country.

This progress report was accepted.

13. Teaching Load for Chemistry Teachers: J. E. MILLS, *chairman* of this new and not yet fully organized committee, presented by letter a progress report which was accepted.

14. Women's Club Study Course: HARRISON HALE, *chairman*, reported by letter as follows:

Your committee on Women's Club Study Course in chemistry wishes your advice. During the past year, through the *News Service*, wide publicity was given to the Club Study Course, especially in the New York papers and in the local papers at the time of the Atlanta and Cincinnati meetings. Much of this came after clubs had chosen their course of study for the following year.

Letters were written to officers of many clubs with only a low percentage of answers. Letters were sent also to several hundred members of the American Chemical Society asking them to bring the course to the attention of clubs in their vicinity. The replies received from these members and their interest and willingness to help were gratifying.

However, there are not more than five clubs enrolled for the course and all of these are in Arkansas, Oklahoma, and Mississippi. It has been suggested that some member of the Society be asked to take charge of the work in each state.

The report was accepted.

15. Special Committee to Study and Prepare a Report upon the Subscription Lists of the JOURNAL OF CHEMICAL EDUCATION: NEIL E. GORDON, *chairman*, reported as follows:

On October 15, 1930, a questionnaire was sent out to JOURNAL subscribers asking for opinions as to the relative merits of various types of articles published in the JOURNAL and as to the size of the publication itself, with suggestions as to any additions or eliminations that might be desired. Of approximately 4000 questionnaires mailed to subscribers, 1485 (37%) were returned as of December 31, 1930. The following is a tabulation of the replies:

	Helpful	*Most Helpful*	*Unmarked*
Frontispiece with Biographical Sketch.....	856	222	407
Editorial Section.....	809	158	518
General Review Articles.....	692	455	338
Historical Articles.....	760	438	287
Educational Studies and Statistics.....	593	360	532
Teaching Methods.....	445	668	372
Experiments and Apparatus.....	624	591	270
Correspondence Section.....	448	50	987
Digests.....	768	206	511
Abstracts.....	683	320	482
Local Activities Section.....	511	98	876
Book Reviews.....	848	243	394
Advertising.....	600	66	819
Do you find the JOURNAL too large?.....	1063 (No)	175 (Yes)	247

The *Secretary*, who served as the other member of this committee, about the same time mailed a letter to 400 former subscribers who had dropped their subscriptions, asking if they had been dissatisfied with the JOURNAL in any way. Fifty-three replies were received (12½%), fourteen of which certified that subscriptions had been renewed. Those who had frankly dropped the JOURNAL were distributed as follows:

Changed profession	12
No time to read	6
Finances will not permit	10
Miscellaneous (in most cases involving change in profession)	8

It is obvious that the large turnover among subscribers to the JOURNAL who are teachers of secondary chemistry must bear some relation to the large employment turnover among the same group. It seems reasonable to conclude that a considerable proportion of the 37½% who did not respond to the letter of inquiry are not now teaching chemistry.

The report was accepted and the committee discharged.

Miscellaneous Business

1. It was voted to grant requests of standing committees as follows:
   (*a*) *Committee on Naming and Scope of Committees:* $20.00 to December 31, 1930, and up to $25.00 during 1931.
   (*b*) *Chemical Education by Radio:* $35.00 for immediate use.

(*c*) *Preparation of High-School Chemistry Teachers:* up to $20.00, for immediate use.

(*d*) *Teaching Load for Chemistry Teachers:* Up to $25.00 for immediate use.

(*e*) *Visual Aids in Chemical Education:* $18.75 to December 31, 1930.

2. The *Secretary* was instructed to set a time at each convention of the A. C. S. for meetings of the standing committees.

Note: For the Indianapolis meeting, the period from 11–12 following the Senate meeting, Wednesday, A.M., April 1st, has been so designated. The place will be announced later.

3. Voted to accept resignation of M. V. MCGILL as chairman of Committee on Chemistry Clubs.

4. Voted the members of the editorial board be placed upon the complimentary subscription list of the JOURNAL OF CHEMICAL EDUCATION, each departmental editor to be allowed two additional copies of each issue for his departmental use.

5. The following departmental editors were appointed for a period of three years beginning July 1, 1931:

W. MCPHERSON	*Graduate Chemistry*
H. C. SHERMAN	*Undergraduate Chemistry*
L. C. NEWELL	*Historical Chemistry*
R. E. ROSE	*Industrial Chemistry*
W. SEGERBLOM	*High-School Chemistry*
R. A. BAKER	*Abstracts*

6. Voted to authorize J. N. SWAN to go through the JOURNAL records which have accumulated in the office of the Business Manager and to make such disposition of them as to him seems warranted.

7. The budget for 1931 was discussed and adopted as follows:

Expenditures:	
Stationery for officers and committees	$300.00
Miscellaneous postage	50.00
Standing committees, at least	500.00
Mid-winter Meeting of the Executive Committee	400.00
Semi-annual meetings	200.00
Dr. Swan's services (Office of the Business Manager)	450.00
Secretary's Office	
Secretarial assistance	2400.00
Traveling expenses	200.00
Postage, telegrams, etc.	300.00
Office supplies	250.00
Stationery for officers and committees	300.00
Membership forms, circular letters, constitution, reprints, etc.	250.00
	$5600.00

Receipts:

Enrolment fees—active members	$100.00
Requested of The Chemical Foundation	5500.00
	$5600.00

8. It was voted to request the Committee on Naming and Scope of Committees to consider the advisability of appointing committees to study the following problems:

(*a*) Correspondence courses.
(*b*) Minimum standards of teaching force and equipment for various degrees in chemistry.
(*c*) Vocational guidance.
(*d*) Juvenile training in chemistry.
(*e*) Museums.
(*f*) Optimum size of recitation and laboratory sections.

Adjourned at 12.30 P.M., having been in session as follows: Friday, January 2nd, 10.00 A.M. to 12.45 P.M., and 1.30 to 5.30 P.M.; Saturday, January 3rd, 9.00 A.M. to 12.30 P.M.

R. A. BAKER, *Secretary*

Dose of Copper Needed to Make Oysters Settle Down. Young oysters will not forsake a roving life and settle down to business until they have had a taste of copper.

This has been discovered through researches of H. F. Prythearch of the U. S. Bureau of Fisheries, who has been investigating the life history of oysters as a part of the government's drive to make oysters more abundant again.

When an oyster first hatches from the egg, it lives for a couple of weeks as a free-swimming larva, propelled through the water by the lashings of a multitude of hair-like processes called cilia. This free-swimming period in their lives secures the wide distribution of the oyster young.

At about two weeks of age it is ripe to settle down. But it does not do so unless it receives its dose of copper. Lacking that, it continues to swim aimlessly about, becomes prematurely old and dies a prey to swarming microörganisms.

If it gets its few molecules of copper, its cilia cease to wave, and it settles to the bottom. There it protrudes its one foot, and proceeds to crawl laboriously about for a while.

Finally it extrudes a little glue-like stuff, plants one of its two shells squarely in that, and thereafter is a fixed and solid citizen of the oyster commonwealth.

It takes very little copper to make an oyster larva quit swimming and adopt the sessile life of the adult form. One part of copper in fifty millions of water will turn the trick. Mr. Prythearch demonstrates the importance of copper in oyster "setting" to oystermen by first showing them the free-swimming larvae under the microscope, and then dipping a penny in the water for a few seconds. Enough copper salt dissolves off the coin in that brief period to have the needed effect on the young oysters.

The relation of copper to oyster "setting" was discovered by accident, through the introduction of minute traces of copper into laboratory water supplies from a brass-lined pump. In nature, the copper is brought down to the brackish water of the oyster beds by freshwater streams.—*Science Service*

Correspondence

AN OFFICE SEEKER OF SOME INITIATIVE

Editor's Note: One of our correspondents, Dr. A. E. Marshall, 501 Fifth Avenue, New York City, interested in the history of The Much Woolton School, founded some time in the 1500's and said to be "the oldest Lancashire elementary school," recently ran across a copy of a delightful letter preserved in the Warden's Books of Childwall. The letter,* which is printed below, is a marvelous example of the gentle art of letter writing as practiced in the 17th century and will doubtless be of interest to those educators who concern themselves with happenings of the past.

Childwall, Aug. 7, 1641

MR. CASE,—

It seemes you intend to teach a Parish Schoole here att Much Woolton, without the consent of the Parish; and indeed against the generall vote of the Parishioners; it is well knowne the house was built at a common charge, and for likewise was the stocke then raysed and beene ever since continued and augmented: therefore we conceive that all have interest in the choise of a master. Now for your part: the truth is you have tyred us in this kind, above tenne yeares agoe: (as you have done other neighbour Schooles, both before and since): besides in thus goeing about to make new titles, you endeavour as much as in you lyes, to stirr up suits, factions and debates in the parish. Soe haveing seriously considered of this cause (which soe neereley conceives us), these are in a faire and loveing way to wish you in time to desist, and in case you be obstinate, then to give you notice that you are not to expect any schoole wages but what you may obtaine by lawe. Thus haveing in the beginning given you this friendly warneing.

Your loveing friends:
(here follow the names of 59 Tithe Payers)

CENTIGRADE-FAHRENHEIT TEMPERATURE CONVERSION

DEAR EDITOR:

Recent notes in the JOURNAL OF CHEMICAL EDUCATION have discussed the advantages of different methods for calculating Centigrade-Fahrenheit temperature conversions. Joseph G. Blann, in the December issue,[1] uses the equivalence of 212°F. and 100°C. as the point of reference in order to eliminate the troublesome 32°F. transition involved when one starts with the equivalence of 32°F. and 0°C. In the February issue, both Alfred

* BROWN, R. STEWART, "Notes on Childwall," Liverpool, 1919.

[1] BLANN, J. CHEM. EDUC., 7, 2946–7 (Dec., 1930).

M. Ewing[2] and Herman W. Woods[3] call attention to the much simpler system of referring calculations to the equivalence of $-40°$F. and $-40°$C. In both places emphasis is placed on the graphical presentation of the temperature scales and the relative sizes of the two units.

For the beginning student and his teacher, the graphical presentation of the relation between the two temperature scales is perhaps more important than the formula, whatever formula is suggested, because the student who has such a picture clearly in mind can make his calculations intelligently without the need of memorizing algebraic expressions or limiting himself to any one point of reference.

The advanced student, or the practicing chemist or engineer, is not likely to come out with a wrong result in this simple conversion, but if he encounters it frequently he may welcome the following suggestion which further simplifies the arithmetic involved in converting temperatures from degrees Centigrade to degrees Fahrenheit.

Given the Centigrade value, add to it one-tenth the difference obtained by subtracting that value from 160, and double the result.

When a rapid conversion must be made mentally, this method will be found much easier to handle than any other, since it avoids the fraction 9/5 altogether and the value $(160 - °\text{C.})/10$ can always be obtained at once by inspection. For example:

°C.	45	72.3	148	500	17.460
$(160 - °\text{C.})/10$	11.5	9.77	1.2	−34.0	14.254
	56.5	82.07	149.2	466	31.714
°F.	113	164.14	298.4	932	63.428

The method is perfectly accurate and can be derived from the more familiar formula as follows:

$$\begin{aligned} °\text{F.} &= \tfrac{9}{5}°\text{C.} + 32 \\ &= 2°\text{C.} - \tfrac{1}{5}°\text{C.} + 32 \\ &= 2°\text{C.} + \frac{160 - °\text{C.}}{5} \\ &= 2\left(°\text{C.} + \frac{160 - °\text{C.}}{10}\right) \end{aligned}$$

A similar method for the reverse conversion, viz.,

$$°\text{C.} = \tfrac{1}{2}\left(°\text{F.} - \frac{320 - °\text{F.}}{9}\right),$$

offers no advantage over the methods previously suggested because it still involves division by 9.

ROBERT N. WENZEL

MELLON INSTITUTE OF INDUSTRIAL RESEARCH
PITTSBURGH, PENNA.

[2] EWING, J. CHEM. EDUC., **8**, 370 (Feb., 1931).

[3] WOODS, *ibid.*, **8**, 370 (Feb., 1931).

DEAR EDITOR:

The criticisms made by Blann[1] concerning the 32° method of conversion seem to many teachers to be well founded.

In teaching elementary physics for many years I have employed as the basis for a very simple rule the two facts, (1) that the relative magnitude of the two kinds of degrees is in the ratio 5/9, and (2) that the number *minus* 40° expresses the same temperature in both scales.

Rule (1) To the given temperature *add* 40;
(2) Multiply this sum by 5/9 or 9/5;
(3) From this product *subtract* 40. The remainder is the desired temperature expressed in the other scale.

For those who desire a mathematical formula the relation may be expressed

$$\frac{F. + 40}{180} = \frac{C. + 40}{100}$$

or

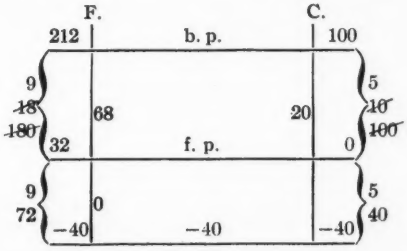
$$\frac{F. + 40}{9} = \frac{C. + 40}{5}$$

HUBERT G. SHAW

GEORGIA SCHOOL OF TECHNOLOGY
ATLANTA, GA.

DEAR EDITOR:

In connection with the article by Blann[1] in a recent issue of the JOURNAL OF CHEMICAL EDUCATION, the results of the application of the following plan of temperature conversion to a teaching experiment may be of interest.



Drawing the diagram herewith reproduced as points are mentioned, the pupils fasten first the idea of three points of equivalence on the two scales. Then the degree-distance between these points is called to their attention, and the intervals indicated are reduced to lowest terms, fastening the concept of the 9:5 ratio. This ratio is tried out on a few examples, such as 110°C. being 18°F. more than 212°F.; this also shows the better students how they may use the 1.8 multiplier instead of 9/5 (or also 1.8 as a divisor

[1] BLANN, J. CHEM. EDUC., 7, 2946–7 (Dec., 1930).

instead of multiplying by 5/9). It pays to use a few examples involving negative readings. The rule is simply "add 40, multiply by your fraction, subtract 40" and applies in either direction. With the ratio of 9°F. = 5°C. in mind, the proper fraction is easily selected, for the student is made to realize that there are more F. degrees than C. degrees for a given interval.

The experiment in teaching was applied to three ability-grouped classes in general science at West High School, Cleveland. The *x*, or best group, was two days ahead of the other groups, and was given the old method using the addition or subtraction of 32° on the Fahrenheit side. After two class periods, less than 60% of the class could perform the conversion with consistent accuracy. The third day, about 20 minutes served to bring the entire group to a comprehension of the "minus 40 method," and the performance was almost perfect. The *y*, or average group, was given only the method shown here, with the use of fractions only—not the 1.8 decimal. They mastered the situation to a 90% performance within 35 minutes. The lowest group was not strictly *z*, but managed to attain over 75% performance within a 45-minute period; about ten minutes more spent with the few individuals who needed it served to bring comprehension to them.

At a later date, in two classes in chemistry which were fairly well equated on chemistry performance, the two methods were tried, the "32 method" in one group and the "minus 40 method" in the other. The resulting tabulation of errors is not at hand, but was so overwhelmingly in favor of the "minus 40 method" that the other has since been discarded entirely.

The writer has set up a further analysis of such errors, by a battery of tests now being used in coöperation with the state-wide testing program of the Department of Education of Ohio. The results of analysis of several thousand papers will soon be available.

HAROLD WM. BAKER

BUREAU OF EDUCATIONAL RESEARCH
THE OHIO STATE UNIVERSITY
COLUMBUS, OHIO

Three Motion Pictures Available for Free Use in Educational Institutions. The De Frenes & Company of Wilkes-Barre, Penna., announce for free use in educational institutions the following three motion pictures:

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"American Glove Craft," three reels. This film shows the complete process of tanning various kinds of glove leather and the making of fine leather gloves.

All three films are available in 16-mm. and 35-mm. safety stock.

Chemical Digest

CODE OF ETHICS, THE AMERICAN INSTITUTE OF CHEMISTS

The profession of chemistry has become an increasingly important factor in the progress of civilization, and in the welfare of the community. Chemists are entitled to the position and authority which will enable them to discharge their responsibilities properly and to render effective service to humanity. In order that the honor and dignity of the profession be advanced and maintained, THE AMERICAN INSTITUTE OF CHEMISTS has prepared the following code to define the rules of professional conduct and ethics, binding on its members.

1. Every individual, on entering the profession of chemistry and thereby becoming entitled to full professional fellowship, incurs an obligation to advance the science and art of chemistry, to guard and uphold its high standard of honor, and to conform to the principles of professional conduct.

2. It is the duty of a chemist to bear his part in sustaining the laws, institutions, and burdens of his community.

3. The chemist shall not knowingly engage in illegal work or cooperate with those who are so engaged.

4. A chemist shall carry on his professional work and act in a strict spirit of fairness to employers, contractors, and clients, and in a spirit of personal helpfulness and fraternity toward other members of the chemical profession.

5. He shall refrain from associating with or allowing the use of his name by any enterprise of questionable character.

6. He shall advertise only in a dignified manner, being careful to avoid misleading statements.

7. He shall coöperate in upbuilding the profession by exchanging general information and experience with his fellow chemists, and by contributing to the work of technical societies and the technical press, where such information does not conflict with the interests of his client or employer. It is very desirable that the first publication regarding inventions or other scientific advances be made through the technical societies and technical publications and not through the public press. Care shall be taken that credit for technical work be attributed as far as possible to the real authors of the work.

8. If in his opinion work requested of him by clients or employers seems to present improbability of successful results, he shall so advise before undertaking the work.

9. He shall be conservative in all estimates, reports, testimony, etc.,

and especially so if these are in connection with the promotion of a business enterprise.

10. He shall not accept compensation, financial or otherwise, from more than one interested party without the consent of all parties concerned, and shall not accept commissions from outside parties on sales to his client or employer without their knowledge. He is, however, in no way debarred from accepting employment for more than one employer where there is no conflict of interests.

11. He shall not use any unfair, improper, or questionable methods of securing professional work or advancement, and shall decline to pay or accept commissions for securing such work.

12. He may use all honorable means in competition to secure professional employment but shall not, by unfair means, injure directly or indirectly the professional reputation, prospects, or business of a fellow chemist; and shall not attempt to supplant a fellow chemist after definite steps have been taken toward the latter's employment.

13. He shall not knowingly accept employment by a client or employer while the claim for compensation or damage, or both, of a fellow chemist, previously employed by the same client or employer and whose employment has been terminated, remains unsatisfied, or until such claim has been referred to arbitration, or issue has been joined at law, or unless the chemist previously employed has neglected to press his claim legally.

14. He shall be diligent in exposing and opposing such errors and frauds as his special knowledge enables him to recognize.

15. Any infractions of these principles of professional conduct, coming to his attention, shall be reported to the Ethics Committee of The American Institute of Chemists.

16. He shall not attempt to compete with a fellow chemist on the basis of professional charges, by reducing his usual charges in order to underbid, after being informed of the charges named by the competitor.

17. He shall not accept any engagement to review the professional work (except journal articles and similar scientific publications, and in litigation) of a fellow chemist without the knowledge of such chemist, or unless the connection of such chemist with the work has been terminated.

18. When undertaking work for a client or employer, he should enter into an agreement regarding the ownership of any and all data, plans, improvements, patents, designs, or other records which he may develop or discover while in the employ of such a client or employer. In the absence of a written understanding the following principles are held to apply:

(*a*) If a chemist uses information obtainable only from his client or employer which is not common knowledge or public property, any

results in the form of designs, plans, inventions, processes, etc., shall be regarded as the property of the employer.

(*b*) If a chemist uses his own knowledge, or information, or data which by prior publication or otherwise are public property, then the results in the form of designs, plans, inventions, processes, etc., remain the property of the chemist, and the client or employer is entitled to their use only in the case for which the chemist was retained.

(*c*) All work and results accomplished by the chemist outside of the field for which he was employed or retained are the property of the chemist.

(*d*) Special data or information obtained by a chemist from his client or employer, or which he creates as a result of such information, are to be considered confidential, and while it is ethical to use such data or information in his practice as forming part of his professional experience, its publication without permission is improper.

19. He shall as far as possible in consulting work fix fees at a point high enough to warrant complete and adequate service. Unreasonably low charges for professional work tend toward inferior and unreliable work. In fixing fees it is proper for him to consider:

(*a*) The time and labor involved, the novelty and difficulty of the matter, and the experience and skill necessary.

(*b*) Whether the employment precludes other employment in similar lines or will involve the loss of other business while engaging in the particular work.

(*c*) Customary charges of chemists for similar service.

(*d*) The magnitude of the matter involved, and the benefits resulting to the client from the services.

(*e*) The character of the employment, whether casual or for an established and constant client.

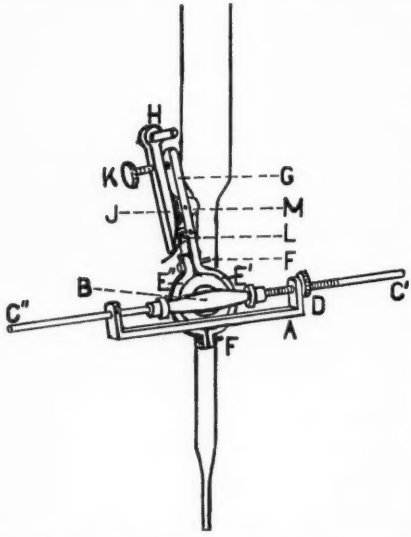
20. While it is desirable that chemists engaged in teaching and research should be permitted to use their special knowledge and skill in direct service to individual clients, it is prejudicial to the welfare of the profession for such services to be rendered at rates which ignore ordinary costs of equipment, supplies, and overhead expenses.

21. Having established a fair fee and billed same to a client, he should oppose any effort of a client to have such fee reduced without real and sufficient cause. Wherever compatible with self-respect and the right to receive a reasonable recompense for services rendered, controversies with clients regarding compensation are to be avoided. There should, however, be no hesitation to apply to the courts for redress to prevent injustice, imposition, or fraud.—*The Chemist*, **8**, 47–9 (Nov., 1930).

Abstracts

APPARATUS, LABORATORY PRACTICE, AND DEMONSTRATIONS

An Adjustable Drop-Control for Burets. F. HOLLANDER. *Science*, **73**, 45–6 (Jan. 9, 1931).—As shown in the figure, the stationary part of the drop-control (*EGJH*), which carries the stop (*H*), is attached to the sleeve of the stopcock; the movable handle (*A*) which strikes against the stop is attached to the glass plug. To insure rigidity of the handle, the rod (*C'*) can be screwed tight against the handle of the plug (*B*) and can be clamped there by means of the nut (*D*). The stationary part of the device is clamped to the wider end of the glass sleeve by means of the semi-circular bands (*E'* and *E''*), which are fastened together by two screws (*F*). One of these bands (*E'*) is an extension of the body (*G*); the other band is separated from it. The rod (*H*) serves as a stop to the rotating rod (*C'* or *C''*) when it is desired to release a drop of reagent. This stop is set perpendicularly into the arm (*J*) which in turn is supported by (*G*). Support is effected by means of the projection (*M*) which passes through a hole in (*G*) and is held there by a pin, thus permitting a slight rotation of the arm (*J*) about the pin as a fulcrum. The rotation is controlled by the screw (*K*) which passes through (*J*) and rests against (*G*). Movements of the arm, imparted by the screw, are opposed by the spring (*L*), which is held in a second hole in (*G*) by means of a pin. The free end of the spring is extended in such a way as to pass against the lower end of (*J*). In attaching the stationary part, the body (*G*) is set at such an angle to the vertical that when the rod (*C''*) touches the stop (*H*), drops will flow from the buret tip at a slow but steady rate. Flow is controlled by adjusting the screw (*K*). G. H. W.



A New Method for Recording Electrons. P. H. CARR. *Rev. Sci. Instruments*, **1**, 711–43 (Dec., 1930).—"A brief review is given of the use of photographic plates for the recording of electrons. Photographic plates are rendered more sensitive to the action of electrons by the application of a small amount of certain oils; but whether oiled or not, photographic plates are insensitive to the action of electrons when they strike the plate with a speed of less than 25 equivalent volts. This work indicates that the sensitizing action of oil is largely due to cathode-luminescence of the oil, and that the failure of the photographic plate to record low-speed electrons is due to the high electrical resistance of the photographic emulsion. Announcement is made of the discovery of the fact that metal surfaces are affected by electron bombardment in such a way that the bombarded regions react differently toward certain vapors than do the unbombarded regions. This effect has been observed even when the speed of the impinging electrons was only 12 equivalent volts. Experiments on silver and gold are presented in detail, and the practical use of the effect for electron recording demonstrated. Possible causes of the effect are also discussed. When the two methods for recording electrons are compared, it is found that the photographic method has the advantage of speed and ease of reproduction, while the metal method has the advantage of reliability, freedom from charging up, and insensitivity to light. Moreover, the metal method can be used for lower speed electrons than can the photographic method." R. L. H.

Silvering Mirrors. *Brass World*, **26,** 303 (Nov., 1930).—A process is given for silvering mirrors and is recommended to give excellent results. R. L. H.

Make Synthetic Dyes at Home. R. E. SADTLER. *Sci. & Inv.*, **18,** 814 (Jan., 1931).—Directions for preparing methyl orange, fuchsine, indigo, phenol, fluorescein, and eosin are given for the amateur chemist. Illustrated. E. L. C.

Textile Microscopy. H. ELLIS. *Textile Recorder*, **48,** 33–4 (Dec., 1930).—Directions are given for preparing type specimens of vegetable fibers. This includes discussion of various media, methods of mounting, and preparation of cross-sections. Illustrated. Third in series on this subject. E. L. C.

Future Textile-Laboratory Practice. G. B. HAVEN. *Textile World*, **79,** 42–4 (Jan. 3, 1931).—Second and concluding instalment of abstract of paper given at meeting of Textile Committee of American Society for Testing Materials. Prof. Haven, who is in charge of textile research at Massachusetts Institute of Technology, describes apparatus for testing thickness, abrasion, resilience, and bursting strength in this article. E. L. C.

The Detection and Determination of Pyridine. S. B. TALLANTYRE. *Chem. & Ind.*, **49,** 466T–468T (Dec. 5, 1930).—Several methods for the extraction and precipitation of pyridine bases are described. One or two cc. of a dilute solution of cyanogen bromide in water, with one drop of aniline, if shaken with 50 cc. of 0.001% pyridine solution will give a bright yellow color. This seems to be a specific test for pyridine. E. R. W.

Inorganic Lubricants. III. Mixtures of Aqueous Liquids with Non-Reacting Solids. W. A. BOUGHTON. *J. Am. Chem. Soc.*, **52,** 4335–6 (Nov., 1930).—Water mixed with fine powders to form a paste may be used as a lubricant. "Of the mixtures prepared, the best for general use were those of kaolin and of graphite, with calcium chloride solution."

Useful in working with organic water-insoluble liquids or gases which attack organic lubricants. H. H. K.

Inorganic Lubricants. IV. Lubricants for Temperatures Above and Below Normal. W. A. BOUGHTON. *J. Am. Chem. Soc.*, **52,** 4858–60 (Dec., 1930).—Aqueous metaphosphate and metaphosphoric acid solutions heated to the proper temperature yield clear viscous solutions capable of operating up to 160 degrees.

Certain fused salts mixed with kaolin or graphite can be used as high as 360 degrees.

For temperatures below normal metaphosphoric acid is useful down to −75 degrees. H. H. K.

The Development of the Organic Elementary Analysis. See this title on page 745.

TEACHING OBJECTIVES, METHODS, AND SUGGESTIONS

Laboratory Supply Companies. J. M. MICHENER. *Sch. Sci. Math.*, **30,** 962, 964 (Nov., 1930).—"It is quite common to find a science teacher who buys chemicals and apparatus from only one or two laboratory supply companies and who does not know that there are many other firms in this business. These companies are scattered all over the country and all of them publish catalogs, some of them very complete and containing information of much value to the science teacher.

"It would pay practically every science teacher to obtain copies of the catalogs of these companies because a study of their catalogs will give much information, and an increasing acquaintance with the many different kinds of apparatus which are illustrated and described therein. A list of the companies and their addresses is as follows:

BIOLOGICAL SUPPLY COMPANY, 1176 Mt. Hope Avenue, Rochester, N. Y.
BRAUN-KNECHT-HEIMANN COMPANY, 576 Mission Street, San Francisco, Calif.
BRAUN CORPORATION, 363 New High Street, Los Angeles, Calif.
BURRELL TECHNICAL SUPPLY COMPANY, 1704 Fifth Avenue, Pittsburgh, Penna.
CAMBRIDGE BOTANICAL SUPPLY COMPANY, 1 Lexington Street, Waverley, Mass.
CENTRAL SCIENTIFIC COMPANY, 460 East Ohio Street, Chicago, Ill.
CENTRAL SCIENTIFIC CO., EASTERN DIVISION, 79 Amherst Street, Cambridge, Mass.
CHICAGO APPARATUS COMPANY, 1735 N. Ashland Avenue, Chicago, Ill.
CHEMICAL RUBBER COMPANY, THE, W. 112th Street and Locust Avenue, Cleveland, Ohio.
CINCINNATI SCIENTIFIC COMPANY, 210 E. 2nd Street, Cincinnati, Ohio.
CLAFLIN COMPANY, GEORGE L., 70 South Main Street, Providence, R. I.
DAIGGER AND COMPANY, A., 159 W. Kinzie Street, Chicago, Ill.
DENVER FIRE CLAY COMPANY, 1742–46 Champa Street, Denver, Colo.
EBERBACH AND SON COMPANY, Ann Arbor, Mich.
EIMER AND AMEND, Third Avenue, 18th to 19th Streets, New York, N. Y.

EMPIRE LABORATORY SUPPLY COMPANY, 507 W. 132nd Street, New York, N. Y.
FISHER SCIENTIFIC COMPANY, 709 Forbes Street, Philadelphia, Penna.
GREINER COMPANY, EMIL, 55 Vandam Street, New York, N. Y.
HEIL CHEMICAL COMPANY, HENRY, 212 S. Fourth Street, St. Louis, Mo.
KAUFFMAN-LATTIMER COMPANY, 41 E. Chestnut Street, Columbus, Ohio.
KNY-SCHEERER CORPORATION, 10 W. 25th Street, New York, N. Y.
LABORATORY MATERIALS COMPANY, 640 E. 71st Street, Chicago, Ill.
MCKESSON-BEDSOLE-COLVIN-O'DELL, 1706 First Avenue, Birmingham, Ala.
PALO COMPANY, 153 W. 23rd Street, New York, N. Y.
SARGENT AND COMPANY, E. H., 155 E. Superior Street, Chicago, Ill.
SCHAAR AND COMPANY, 556 W. Jackson Boulevard, Chicago, Ill.
THOMAS COMPANY, ARTHUR H., W. Washington Square, Philadelphia, Penna.
UNIVERSAL SCIENTIFIC COMPANY, 11 E. Austin Avenue, Chicago, Ill.
UNIVERSITY APPARATUS COMPANY, 2229 McGee Avenue, Berkeley, Calif.
WELCH SCIENTIFIC COMPANY, W. M., 1516 Orleans Street, Chicago, Ill.
WILKENS-ANDERSON COMPANY, 217 N. Desplaines Street, Chicago, Ill.
WILL CORPORATION, 845 Merle Street, Rochester, N. Y." B. H. B.

Some Heroes Who Deserve Attention. L. P. MILLER. *High-Sch. Teacher*, **6**, 414 (Dec., 1930).—"The heroes of science . . . are . . . deserving of attention in our high schools . . . (along with) the heroes of wars or of letters." The author advocates co-operation among English, history, and science teachers in presenting to high-school pupils the joint accomplishments of the heroes of science, and the methods used by them in arriving at those results. Several suitable sources of material are mentioned. B. C. H.

The Notebook Problem. EDIT. *Sci. Classroom*, **10**, 1 (Nov., 1930).—The two major considerations in the article are (1) the value and (2) types of notebooks.

Values are listed as induce pupil activity, train in concise and accurate expression, help measure pupil progress, lend coherence to the work, aid review, and may become a source of pupil motivation when properly handled by the teacher.

Two types of books are set forth, the most common being that which demands uniform records from all. This may go so far as to even prescribe the steps for the write-up of an experiment or a demonstration. The other type of book permits each pupil to have much leeway in the choice of subject matter that goes into it and the style in which it shall be made up. The second type is the one which is most likely to motivate the pupil to do some self-initiated and creative work.

Some wholesome suggestions for the teacher's guidance in making the most of the pupil's notebook as a teaching tool concludes the article. B. C. H.

The Assignment for Tomorrow. EDIT. *Sci. Classroom*, **10**, 1 (Dec., 1930).—"A teacher's success may often be measured by the response of the class when she announces the next day's assignment." To aid the teacher in adding novelty to the assignment the editor of the *Classroom* ventures some new turns that assignments may take.

Home-made apparatus may be suggested as an assignment. Home work doesn't always have to be written. The bulletin board with its new display of clippings, pictures, and diagrams headed by a pertinent question may serve in such a capacity. Or there may be some local point of interest in connection with the next day's lesson which would add life to the class's work if reported by a first-hand observer. Thus the excursion becomes, for such a one, "tomorrow's assignment." When the science question box is opened some of its interrogations may be passed to the pupils as tomorrow's assignment, and some of those new demonstrations may be shared by the teacher with his pupils in the form of a part, at least, of the next day's assignment. B. C. H.

A Chart of Consecutive Sets of Electronic Orbits within Atoms of Chemical Elements. V. KARAPETOFF. *J. Frank. Inst.*, **210**, 609–24 (Nov., 1930).—A presentation, partly in chart form, of the results of studies of a number of prominent physicists who have collected considerable information as to the probable number of electronic orbits and their characteristics for practically all known chemical elements. The principal source of such information is the study of the spectral lines of such elements interpreted in terms of the so-called quantum theory of elementary action. J. H. G.

The Home Economics Teacher Meets the Unemployment Problem. C. E. YOUNGS. *Pract. Home Econ.*, **9**, 1 (Jan., 1931).—Teachers because they are on regular salaries and these salaries have increased in purchasing power can keep up their usual quota of buying and help in the turnover of goods, and also contribute more generously to community funds.

A multitude of ways in which the home economics teacher can especially help in

her classes is suggested. Lessons should be planned in the foods classes which include the substantial and practical to the exclusion of elaborate and expensive combinations. Show how food costs may be cut without lowering standards of nutrition, not less food but equal nourishment for less money. Malnutrition is not real economy. Emphasize serving based on simplicity, marketing with economy, elimination of food waste, economical and pleasant use of left-overs.

In clothing classes emphasize thrift in purchasing and care of clothing, the relation of clothes to health, the setting up of conservative style standards, remodeling of old clothes.

The thrift campaign can be further carried to a study of the average household wastes of light, gas, hot water, cleaning and laundry supplies, unnecessary food between meals, losses of personal belongings due to carelessness.

Girls can be taught to earn money outside of school hours by practical suggestions about taking care of children; how to wait on table and assist at small parties; how to do acceptable mending; how to make and sell some special food product. J. W. H.

Examinations in Textile Technology. See this title on page 750.

ADMINISTRATIVE PROBLEMS AND DEVICES; CURRICULA

Personal Relations of Teachers with Students. C. L. KINSLOE. *J. Eng. Educ.*, **21,** 269–73 (Dec., 1930).—Failure of engineering students to make satisfactory progress in the years immediately following graduation are usually not due to insufficient academic preparation. The problem is one of human relationships and contacts. The dept. of electrical engineering of the Penna. State College, in order to supplement the academic work and improve the personal contacts of the students with teachers, has adopted the practice of assigning a different faculty adviser to each student at the beginning of each year. This adviser is responsible for all matters pertaining to his students' schedules. An orientation course is given the second semester of the freshman year and the first semester of the sophomore year, in which students are divided into groups of fifteen and study simple engineering problems under the direction of some of the older staff members. Informal conferences may be had with the instructors, if desired. Promising members of the senior class are invited to undertake special work with some of the ablest men on the staff. The work is a combination of seminars and personal conferences. Four corporations are coöperating in a course in which the functional organization of industry is studied. Each corporation provides men who act as instructors for a three-week period. The benefits to the students are very real. H. T. B.

Old High-School Ideals on the Dump. EDIT. *School*, **42,** 200 (Nov. 20, 1930).—Doctor David Snedden of the Teachers' College, Columbia University, would wipe all vocational training from high schools. After requiring a four-year high-school course of all who wish to enter vocational work he would have a state system of such schools which are really efficient.

Doctor Snedden would teach only the upper ten or twenty per cent of the high-school students such subjects as Latin, physics, algebra, the English classics, and chemistry. For the other students he would fit the curriculum to the student's needs and not the student to the curriculum. He lists his objectives for these academic high schools as better health, better civism, better reading, teaching of natural science, and appreciation of esthetic cultures. B. C. H.

The Training of Science Teachers for Secondary Schools. H. A. WEBB. *Gen. Sci. Quart.*, **15,** 1–8 (Nov., 1930).—The following schedule is suggested: 1. require one year (9 quarter hours) in each of biology, physics, chemistry, with biology to be taken definitely in the first year. 2. One year (9 quarter hours) in one of these fields: mathematics, agriculture, home economics. 3. Election of an additional year either of two sciences, or one science and either mathematics, agriculture, or home economics. 4. Election of an additional year, a third, in one of the two subjects followed for the two previous years. 5. A course in teaching general science. 6. Require each student in the fourth year to take one course in the teaching of that subject in which he has had three years' study. J. H. G.

Teacher-Training Methods. See **Showing Cadets How in Seattle** on page 749.

KEEPING UP WITH CHEMISTRY

Present Status of Theory and Experiment as to Atomic Disintegration and Atomic Synthesis. R. A. MILLIKAN. *Science*, **73,** 1–5 (Jan. 2, 1931).—Here is given a discussion of ten far-reaching discoveries concerning atomic disintegration and synthesis, all made during the past hundred years:

1. The discovery of the equivalence of heat and work and the consequent formulation of the principle of the conservation of energy.
2. The formulation of the second law of thermodynamics, called by some "heat-death."
3. The discovery of the true facts of evolution.
4. Proof that the dogma of the immutable element is wrong.
5. Discovery, through radioactivity, of the enormous life-time of the earth.
6. The development of evidence for the interconvertibility of mass and energy.
7. The discovery that all the elements are definitely built up out of hydrogen.
8. The discovery of the complete annihilation of positive and negative electrons within the nucleus.
9. In 1927 Aston made a series of measurements on the relative masses of the atoms which made it possible to subject to a new test the Einstein formula for the relation between mass and energy.
10. The discovery of the cosmic rays, which have their origin, not in the stars, but rather in interstellar space, and are due to the building up of the heavier elements out of hydrogen. G. H. W.

Solid Matter: What Is It, and Why? M. L. HUGGINS. *Sci. Mo.*, **32**, 140–9 (Feb., 1931).—Solids differ chiefly in the kinds of atoms of which they are composed and in the arrangement of these atoms in space. This arrangement depends primarily on the valence electrons and the charge on the kernel. Thus the atoms of the rare gases of Group O, having no valence electrons and no charge on the kernel, are held together by "residual affinities" only, and since these are weak they are solids at low temperatures and as such arrange themselves in a regular fashion with atomic centers far apart relative to the size of the kernels. On the other hand, atoms of the halogens, having kernel charges of -7, tend to complete their valence shell. They do this by sharing a pair of electrons between two atoms. The crystal structure of the solid, therefore, should show the atoms in pairs and the distance between two atoms of a pair is less than that between two atoms in different pairs. Other elements are discussed from this standpoint. Numerous diagrams are given to illustrate the arrangement of atoms in the crystal. G. W. S.

X-Ray Studies of the Solid State. B. WARREN. *Rep. New Eng. Assoc. Chem. Teachers*, **32**, 86–92 (Jan., 1931).—The resemblance between the diffraction pattern of a crossed grating and the X-ray pattern of rock salt is very striking. Not only by X-ray analysis of crystals are scientists able to find the position of each atom and the nature of the valence forces that bind them together, but they are now able to analyze the individual atoms, count the number of electrons within the atom, and to find their distribution. O. C.

Arrangement of Atoms in the Crystal. See **Solid Matter: What Is It, and Why?** above.

The Isotopes of Potassium: Their Association with Plant Life. J. G. F. DRUCE. *Chem. News*, **142**, 33–4 (Jan. 16, 1931).—About 60 lb. of ash from potato stalks were extracted with water and the solution neutralized with 4 *N* HCl. The potassium chloride, obtained after repeated recrystallization and heating to the fusing point, showed no sign of any impurities. A determination of the potassium as sulfate gave an atomic weight of 40.8, while the chlorine ratio indicated that 35.46 g. chlorine combined with 40.2 g. potassium.

The author concludes that there is a definite enrichment of the higher isotope of potassium by the plant.

The ash from non-living coniferous wood gave no indication of the higher isotope. F. B. D.

Notable Achievements in Science during 1930. See **Wring Out the Old; Ring In the New** on page 749.

American Chemical Industries. American Cyanamid Company. *Ind. Eng. Chem.*, **22**, 301–2 (Mar., 1930). D. C. L.

American Chemical Industries. The Brown Company. G. A. RICHTER. *Ind. Eng. Chem.*, **22**, 194–5 (Feb., 1930).—This company is today one of the world's largest producers of forest products. D. C. L.

American Chemical Industries. The Koppers Company. *Ind. Eng. Chem.*, **22**, 101–3 (Jan., 1930).—The Koppers Company is primarily an engineering organization serving the coal, coke, steel, gas, and coal by-products industries. Illustrated. D. C. L.

American Chemical Industries. Laclede-Christy Clay Products Company. J. H. MCKELVEY. *Ind. Eng. Chem.*, **22**, 395 (April, 1930). D. C. L.

American Chemical Industries. The International Nickel Company. A. J. WADHAMS. *Ind. Eng. Chem.*, **22,** 806–9 (July, 1930).—History of the development of this company. Six portraits of men instrumental in its development are included. D. C. L.

South's Chemical Progress and Prospects. *Mfgrs. Record*, **98,** 60 (Dec. 18, 1930).—A chemical survey has been made of thirteen southern states and published under the title "Chemical Progress in the South" [see J. CHEM. EDUC., **7** (Oct., 1930)], compiled and edited by the Division of Chemistry and Chemical Technology of the National Research Council and published by The Chemical Foundation, Inc., New York City. The article includes a brief summarization of the results. R. L. H.

More Chemical Products from the South. C. E. MULLIN. *Mfgrs. Record*, **98,** 26 (Nov. 27, 1930).—The author discusses utilization of waste products giving special emphasis to chemical research upon waste on farms as a solution to present-day farm problems. It is suggested that these waste products be utilized in the manufacture of industrial alcohol fuel. Some work has been done on the use of cotton plants after the removal of the cotton in paper manufacture. Corn waste has been utilized in the manufacture of xylose. R. L. H.

Properties and Uses of Helium. W. E. SNYDER AND R. R. BOTTOMS. *Ind. Eng. Chem.*, **22,** 1189–91 (Nov., 1930).—Helium is the only really inert gas produced in commercial quantities. Its solubility in water is 1.48 cc. per hundred as compared with 2.35 for nitrogen and 4.9 for oxygen. Its thermal conductivity is six times that of air. Its rate of effusion is about three times that of nitrogen, while that of hydrogen is about 50% greater. The new airship, ZRS-4, being constructed for the Navy will have a capacity of 6,500,000 cu. ft. of helium which will give it a gross lift of over 210 tons. If filled with hydrogen its lifting capacity would be increased 7–8%, which would be offset by its greater effusion.

Among its other uses it has been shown that in cases of artificial respiration and in connection with diving, an atmosphere of oxygen and helium is superior to other artificial atmospheres. A study is being made of this. Suggested uses due to its inertness and low solubility are in connection with metallurgy, in heating and refrigeration as a heat conductor, as a drying agent, and as a food preservative in excluding other gases. D. C. L.

Ethyl Alcohol. A. A. BACKHAUS. *Ind. Eng. Chem.*, **22,** 1151–3 (Nov., 1930).—Great Britain was about the first country to provide tax-free alcohol, methylated spirits being legalized in 1855. In the United States, tax-free industrial alcohol was not available until 1906. In 1907 less than 2,000,000 gallons were produced, while in 1929 the production was 107,000,000. About 90% of the alcohol is produced from molasses fermentation. Pure cultures of yeast are essential. The molasses diluted with water about 1:4, the acidity regulated to about pH of 5 with sulfuric acid, yeast is added and fermentation is complete in about 30–60 hours. At this acidity butyric organisms are inhibited and this is also the most favorable acidity for the yeast. The fermented mash containing 6–10% alcohol is then distilled. A résumé of Neuberg's theory for the fermentation process is given. D. C. L.

Sodium Metasilicate: Its Place among Industrial Alkalies. J. G. VAIL. *Chem. & Met. Eng.*, **37,** 736–40 (Dec., 1930).—A description is given of the composition and properties of sodium metasilicate. Its use as a cleansing agent is described and illustrated. R. L. H.

Activated Alumina. *Can. Chem. Met.*, **14,** 353 (Dec., 1930).—Activated alumina, a partially dehydrated trihydrate, has recently been developed by the Aluminum Research Laboratories. It will remove 100% of the moisture from air and other gases, until it has absorbed from 8 to 12% its weight after which it will take up from 20 to 25% of its weight in moisture with a lesser degree of efficiency. R. L. H.

Leavened Concrete. EDIT. *Tech. Rev.*, **33,** 31 (Oct., 1930).—"Aerocrete was introduced into the United States two years ago and, following studies at Columbia University, it has been improved so that it now meets the most exacting fire and water-load tests required for flooring materials in New York City.

"Its components are portland cement, sand, and small quantities of lime, aluminum powder, and soda. The aluminum powder in an alkaline solution causes a chemical reaction when this mixture is poured in a thick liquid form, and the hydrogen liberated is the leaven that forms the cellular structure. The 'rising' process is completed within an hour, when hardening sets in. Control of the ingredients makes it possible to vary the expansion from 50 to 150% of the original volume.

"The advantages claimed for Aerocrete as a structural floor are its lightness (20 to 70% that of concrete), high heat-resisting value and sound-insulating properties.

It will reduce by one-fourth the weight of steel necessary to support a building." S. W. H.

The Plastic Age. EDIT. *Tech. Rev.*, **33,** 25 (Oct., 1930).—"Dr. Wilson Compton declares that the aggregate value of plastic products in the United States is already equivalent to one-tenth that of the products of the lumber and woodworking industries combined.

"What are plastics and for what used? Plastic materials may be divided into six groups, according to their method of formation.

"1. *Natural gum, wax, shellac, and asphalt compounds.* Manufactured with or without drying oils in combination with inert fillers such as wood flour, asbestos, clays. *Examples:* phonograph records, battery jars.

"2. *Casein Plastics:* Casein, a by-product of the milk industry, when treated with formaldehyde, forms a hornlike substance, capable of taking a high polish, of being softened by oil and molded. It is non-inflammable and can be made with beautifully mottled effects. *Examples:* pencils, jewelry, translucent materials.

"3. *Albumen Plastics:* Resemble the casein plastics, although more easily molded and dyed.

"4. *Cellulose Base Plastics:* Derived from nitro-cellulose or pyroxylin. Non-heat resistant, flexible, used as a sandwich material between layers of glass in the manufacture of safety glass. *Examples:* toilet articles, photographic films, automobile curtains.

"5. *Cellulose Acetate Plastics:* Closely related to cellulose nitrate except that they are non-inflammable. Because of their lack of plasticity, used largely in sheet form. *Examples:* safety films, cellophane.

"6. *Synthetic Resins:* The most important are the phenolic resins such as Bakelite and the newer materials of the urea-formaldehyde type. Great strength and high insulating qualities. *Examples:* electrical insulators, radio dials." S. W. H.

Rubber Milk. EDIT. *Tech. Rev.*, **33,** 83 (Nov., 1930).—"Latex can be used for a great variety of purposes that crude rubber cannot be. But latex spoils quickly. It was discovered, however, that adding two to five per cent of ammonia kept latex in a stable form for months. The United States Rubber Company took the lead in preserving and shipping latex and during 1929 more than 10,000 tons were brought into the United States.

"Latex is used in can-sealing compounds, cloth and leather cements. Latex paper is being manufactured with unique qualities of strength, water-tightness, and insulation.

"'Ditmarising,' a patented process, uses latex to coat the filling materials of mattresses and cushions, increasing the strength and durability and rendering them immune to moths.

"Latex has been used as a preservative coating for masonry, for making rugs non-slip, in preserving wood, and making pipe joints.

"Cord tire fabric treated with latex seems to be superior to the rubberized variety. Surgeons' gloves made of it are said to resist fifteen or more sterilizations. Leather substitutes and artificial lumber containing latex are other achievements with this material.

"Soles and heels of shoes, battery separators, filter media, and brake and clutch facing are other uses." S. W. H.

Rubber Vulcanized with Trinitrobenzene. U. S. BUR. STANDARDS NOTES. *J. Frank. Inst.*, **210,** 664–5 (Nov., 1930).—Rubber vulcanized with trinitrobenzene has apparently no action on copper, silver, and mercury by reason of its sulfur content. The formula is: pale crepe rubber 100 parts, zinc oxide "Kadox brand," 100 parts, 1,3,5-trinitrobenzene, 2 parts. Time for vulcanization 60 min. at 41°C. J. H. G.

Carbon Dioxide Storage of Fruits, Vegetables and Flowers. N. C. THORNTON. *Ind. Eng. Chem.*, **22** 1186–9 (Nov., 1930).—The use of "Dry Ice" in refrigeration has led to an interest in the effect of CO_2 on perishable foods. Bananas, apples, and citrus fruits were but little affected by concentrations up to 33% and some even higher. Vegetables showed considerably more variation, an excess of moisture being objectionable. This treatment prolonged the life of flowers by retarding the opening of the buds, indicating a gain of about four days. Similar retardation to ripening was shown by some fruits. D. C. L.

Development of the Butyl-Acetonic Fermentation Industry. C. L. GABRIEL AND F. M. CRAWFORD. *Ind. Eng. Chem.*, **22,** 1163–5 (Nov., 1930).—Numerous early workers had noticed the formation of butyl alcohol, but greater interest was displayed after rubber was first successfully synthesized in 1860. Fernback and Weizman in search of a means of producing butyl alcohol in larger amounts found bacteria which produced

amyl and butyl alcohols, and later an organism which produced acetone. These were utilized during the war for the production of acetone necessary in the manufacture of explosives. After the war the demand for acetone ceased, and enormous quantities of butyl alcohol produced along with it were still on hand. Later a large demand was created for butyl alcohol by its use in automobile lacquers. When nitrocellulose of low viscosity became available, so that a sufficiently high concentration could be obtained, butyl acetate was found to be the most suitable solvent.

The process consists in grinding the corn, wheat, etc., to a coarse meal, adding water to give the meal a concentration of about 7%. Cook for two hours, cool and add the Weizmann bacteria, which can be obtained from a variety of sources, soil, fruits, etc. Fermentation is complete in two or three days. The products are then separated by distillation. The products are *n*-butyl alcohol, acetone, and ethyl alcohol in the ratio of 6:3:1. For every pound of solvent, 1.5 pounds of gas are produced. The hydrogen and CO_2 are used in the production of methanol. D. C. L.

Some Minor Industrial Fermentations. O. E. MAY AND H. T. HERRICK. *Ind. Eng. Chem.*, **22,** 1172–6 (Nov., 1930).—Gives a review of the production of citric, gluconic and gallic acids, and glycerol. Raw materials, methods of fermentation, and yields are given. Details of the production of glycerol by the Germans during the war are described. Fermentation of 1 kg. sucrose produced 200–250 g. glycerol, 300 g. alcohol, and 50 g. acetaldehyde. Reactions showing how glycerol is produced in the presence of sodium bisulfite or alkalies are given. D. C. L.

Fermentations in the Food Industries. F. G. BLANCK. *Ind. Eng. Chem.*, **22,** 1166–8 (Nov., 1930).—Various food products of an annual value of one billion dollars utilize fermentation processes in their preparation many of which are not clearly understood. Their relation to bread-making, sauerkraut, vinegar, cheese, pickles, olives, fermented milks, fruit juices, sauces, tea, coffee, and cocoa are described. D. C. L.

Fermentation as a Manufacturing Process. *Chem. & Met. Eng.*, **37,** 623 (Oct., 1930).—Fermentation reactions are essentially catalytic. The catalyst is produced by a living organism during reaction. The first fermentation process to become known to humanity was that of production of ethyl alcohol. The article gives the views of the leading chemists in alcohol production. R. L. H.

Magnetic Separation Purifies Feldspar. C. H. PEDDRICK, JR. *Eng. Mining J.*, **130,** 613–4 (1930).—Adaptation of a recently developed electro-magnetic induction separator has proved very successful since its initial use in September in removing metallic iron, garnet, pyrite, tourmaline, hematite, biotite, and muscovite from ground feldspar, thus producing a product, specially suitable for the glass industry. A thin uniform stream of the crushed material is brought successively under the influence of five magnetic separators which gradually clears the glasspar of the above contaminating materials. A high-grade glasspar is produced. G. W. S.

Reduction of Sulfur Dioxide. G. J. YOUNG. *Eng. & Mining J.*, **131,** 7 (1931).—The sulfur dioxide is reduced to sulfur by CO in the presence of a simple catalyst. The reduction appears to be complete even when the SO_2 is mixed with various amounts of air. G. W. S.

The Solubility of Zinc in Sulfuric Acid. F. W. HARRIS. *Trans. Am. Electrochem. Soc.*, **57,** 313–24 (1930).—The rate with which zinc dissolves in dilute sulfuric acid when constant surface is exposed is measured by the rate at which hydrogen is evolved. Small traces of other metals modify the structure of the cast zinc and change the rate with which it dissolves. A small amount of gelatin in the acid cuts down greatly the rate of solution; sodium silicate has little effect. E. R. W.

Destruction of Chrome Nickel Heating Elements. ANON. *Chem. Age, Mo. Met. Sect.*, **23,** 33–4 (Dec. 6, 1930).—At temperatures above 900°C. chromium trioxide is formed which collects on the cooler portions of the element as a yellow deposit; if the temperature of these cooler portions is above 250°C. a brown deposit of chromium oxide will form. If the wire is separated so that an arc forms or if a short circuit occurs, the temperature may rise to 1250–1400°C. and fusion of the wire takes place. The conductivity of the ceramic insulating material is of less importance than has been assumed. E. R. W.

Couples in the Titration of Acids and Bases. M. L. HOLT AND L. KAHLENBERG. *Trans. Am. Electrochem. Soc.*, **57,** 361–79 (1930).—A large number of metal pairs were tried out for the titration of acids and bases, and the results of these trials are shown in graphical form. The most serviceable pairs were found to be W-graphite (natural), Sb-graphite and W-Ag. No satisfactory explanation has been advanced as to why one couple will serve well in a potentiometric titration and another does not. E. R. W.

A Comparison of Certain Hydrogen-Ion Indicator Electrodes in the Presence of

Ferric Iron. L. W. ELDER. *Trans. Am. Electrochem. Soc.*, **57,** 383–93 (1930).—The glass electrode alone is suitable for measuring pH of the solution throughout the titration, although the hydrogen electrode gives reliable end-points. Solubility products are calculated for ferric hydroxide and for ferrous hydroxide. E. R. W.

King Cotton Has a Dual Nature. P. A. CARMICHAEL. *Mfgrs. Record*, **98,** 24 (Dec. 18, 1930).—Experiments are being carried on with the purpose of turning cotton into rayon in competition with wood pulp. It is expected to utilize the entire plant as well as the lint. Of all plants, cotton is probably the richest in available cellulose. Prof. Cameron of the department of chemistry of the University of North Carolina outlines the experimental results as follows: "A large body of interesting and potentially important scientific data has been accumulated. The results are very encouraging as showing that a preferred harvesting season can be determined at which the maximum cellulose production per acre exists, that all the plant can be utilized, the plant as a whole can be harvested, or the stems separately, and the harvest baled and shipped with or without previous ginning. Actual cost figures for growing and harvesting the crop have been obtained. The cellulose content of measured yield justifies the expectation that cotton can be grown profitably as a source of cellulose for the rayon industry in competition with wood pulp, and even possibly for higher grades of paper." R. L. H.

King Cotton. G. W. PERKINS. *Am. J. Pharm.*, **103,** 28–41 (Jan., 1931).—A popular science lecture presented at the Phila. Coll. of Pharm. and Science. The lecture gives the "family history" of cotton, its various names in different countries, the commercial grades, and the many applications of the cotton fiber, the hull, and the seed. G. O.

New Natural Gas Products. *Mfgrs. Record*, **98,** 37 (Dec. 25, 1930).—Oil production in new fields is usually accompanied by an enormous loss of natural gas, which may be utilized in the production of valuable chemical products. Methane can be treated to yield a mixture of one volume of carbon monoxide and three volumes of hydrogen. Water gas, under the proper treatment, may yield methanol, which is an important solvent, denaturant and an organic intermediate in the formation of other compounds. Methane may be oxidized directly to formaldehyde and other oxygenated products. Many examples are given wherein the waste from natural gas may be utilized in the synthesis of such substances as acetylene, butadiene, ethylene, propylene, and butylene. Some of the liquids produced in the pyrolysis of hydrocarbon gases are benzene, toluene, and xylene. R. L. H.

Some Chemical Aspects of the Origin of Petroleum. S. C. LIND. *Science*, **73,** 19–22 (Jan. 9, 1931).—A summary of this paper is as follows:

"We now know processes either thermal or ionic by which progression both up and down the hydrocarbon series is effected, starting from any member in the series. This leads directly to the complexity found in natural petroleum, as is also found in the electrically synthesized ones. Consequently, the starting material, whether of vegetable, animal, or mineral source, does not need to be a complex mixture, but may be a single chemical species, from which a high degree of complexity is obtained by steps which appear simple and natural when the chemical and thermodynamic properties of hydrocarbons are taken into account. The simplicity of such a mechanism may lend indirect support to the old idea of an inorganic origin from one or a few hydrocarbon gases such as might be produced by the action of water on metallic carbides in the earth's interior. On the other hand, it does not preclude animal or vegetable origin, but strongly suggests that the primary material, whether gaseous, liquid, or solid, is later subjected to thermal (or ionic) agents (or both) which produce the complexity found in nature." G. H. W.

White Gold Jewelry. C. M. HOKE. *Brass World*, **26,** 317–9 (Dec., 1930).—White gold consists of a nickel-gold alloy which usually contains one part gold and three parts nickel. Palladium is used in making up dental gold. Palladium-gold alloys cost more than nickel-gold alloys, are easier to work with, tarnish less, may be enameled and remain beautiful for a long time. Heat treatment as well as composition determine the success or failure of the alloy. R. L. H.

Copper Ores of Northern Rhodesia. ANON. *Eng. & Mining J.*, **130,** 567 (1930).—It is predicted that the Northern Rhodesian copper belt will constitute the greatest individual copper mining center of the world. More than 300,000,000 tons of 3¼% copper have already been developed. The ore is largely sulfide, much of which has been oxidized. Chalcocite is the most important of the sulfides and this is followed by bornite and chalcopyrite. G. W. S.

Progress in Flotation Practice and Equipment. S. J. SWAINSON. *Eng. & Mining J.*, **131,** 69–70 (1931).—The tonnage of ore annually treated in the world by the flotation process has now passed the 100 million mark and is increasing. The chemicals used in

this connection amount to approximately 300,000,000 lb. annually in the United States alone. Many non-metallics may now be floated after receiving the proper chemical treatment. Among these are manganese carbonates and oxides, phosphate rock, fluorspar, baryte, and coal. Old cut-and-try methods are giving way to systematic research. Fine grinding, the use of the microscope, and control of the hydrogen-ion concentration are recognized as essentials to success. The sub-aërated mechanically agitated machine seems better adapted for selective flotation while the free-air machines are favored by the large-scale, low-cost operations. G. W. S.

Producing Sulfur in Newgulf. G. H. REID. *Chem. & Met. Eng.*, **37,** 668–72 (Nov., 1930).—A description is given of the methods used in sulfur production at Newgulf, Texas, by the Texas Gulf Sulfur Company. The Texas Gulf Company and the Freeport Texas Company were responsible for over 95% of the total United States production, and nearly 80% of the total world production. Illustrated with photographs. R. L. H.

The Production of Electrolytic Hydrogen and Oxygen. A. E. R. WESTMAN. *Can. Chem. Met.*, **14,** 338–45 (Dec., 1930).—A complete discussion was given upon the subject including cell design, voltage component, capital cost, output, efficiency, types of cell, cell materials, importance of design, plant layout, rectifying equipment, and preparation of cost data. R. L. H.

Low-Cost Hydrogen Production by Ammonia Dissociation. J. F. T. BERLINER AND G. W. BURKE. *Chem. & Met. Eng.*, **37,** 751–4 (Dec., 1930).—Economic production and distribution of hydrogen has become a factor of primary importance in many industrial processes. Hydrogen in the form of ammonia may be transported, stored, and is readily available for use. It may easily be "cracked" or dissociated into its elements. The product of dissociation contains about 75% by volume of hydrogen. In almost all applications of hydrogen the nitrogen is not detrimental. The author discusses economics of the process, nitrogen production, ammonia cracking equipment, and control apparatus. The article is illustrated with drawings and graphs. R. L. H.

The Manufacture of a Photographic Product. H. BAINES. *Chem. & Ind.*, **49,** 1003–6 (Nov. 28, 1930).—A description, with illustrations and diagrams, of the industrial methods by which photographic film is manufactured. E. R. W.

The Betts Electrolytic Lead Refining Process in Practice. J. J. FINGLAND. *Trans. Am. Electrochem. Soc.*, **57,** 177–205 (1930).—An interesting, illustrated description of the detailed procedure for the refining of lead by electrolysis in a bath of hydrofluosilicic acid. E. R. W.

Are We Nearing Potash Independence? T. R. OLIVE. *Chem. & Met. Eng.*, **37,** 728–31 (Dec., 1930).—Of the three indispensable plant food materials, nitrogen, phosphorus, and potash, only in the case of potash are we dependent upon other countries. Prior to the year 1910 Germany had a monopoly on potash production. At the beginning of the World War, the United States was forced to rely on her own resources for this material, and the industry has been growing since. Oil-well drilling in Texas showed potash-bearing minerals of which polyhalite was the only one bearing potash in commercial quantities. It is produced from this mineral in the form of potassium sulfate for less than $16.00 per ton. The article is illustrated. R. L. H.

Fatalities Due to Vitiated Air Produced by the Oxidation of Vegetable Refuse. A. K. TANKARD AND D. J. T. BAGNALL. *Analyst*, **55,** 673–6 (Nov., 1930).—In January of 1930 a workman collapsed after descending into a manhole which was receiving sub-soil drainage from low-lying land. A second and third workman collapsed in an attempt to rescue the first, and despite all efforts to revive the men they were found to be dead upon arrival at the infirmary. The gas in the manhole was analyzed and was found to contain 10.6% carbon dioxide, oxygen 1.4%, nitrogen 88%, combustible gases, none. Negative tests showed the absence of carbon monoxide. R. L. H.

Metals That We Eat. L. H. BAKER. *Hygeia*, **9,** 35–40 (Jan., 1931).—The newest subject being investigated in experiments from which it is ultimately hoped to determine the essentials for building and maintaining a sound physical body is the effect of metals in the diet. The use of aluminum ware in the kitchen has been much discussed. Recent experiments on rats showed that the presence of aluminum in food had no effect on the body. The substance was found only on the skin, in the lungs, and in the alimentary canal. The housewife need not any longer worry when her discolored aluminum pan becomes bright and shiny after cooking tomatoes, etc. Iron and copper are necessary for the red corpuscles of the blood to function properly. Calcium and phosphorus are essential in bone nutrition. It is planned to investigate the effect of all the substances most commonly met in foods. H. T. B.

Dope: The Story of the Use and Abuse of Opium. H. C. WOOD, JR. *Am. J.*

Pharm., **103**, 16–27 (Jan., 1931).—The poppy which yields the "dope" is an annual herb usually about three or four feet high with coarsely toothed leaves, not dissected as the scarlet poppy, and bearing large flowers which vary in color from almost white to purple. The winter poppy is preferred because it yields a larger harvest. As far as we know no narcotic principle is found in any part of the plant except the fruit, which is a capsule about the size of a small hen's egg. The method of gathering the crop is the same as that described by Dioscorides 2000 years ago. When the evening dew has fallen, the collectors pass through the fields with a sharp knife cutting a number of gashes in the rind of the fruit, not too deeply, but deep enough to let the juice ooze out. The workers gather this juice twenty-four hours later on small trays or on one of the large poppy leaves. The collection of opium does not impair the fruit as the seeds ripen successfully on the plant. Opium stands unrivaled as the "queen of pain assuagers"; but human nature is so constructed that mankind is continually perverting precious gifts to uses by which they become a curse to humanity. Apparently the first people to realize how serious is the peril hidden in the poppy were the Chinese. The white race dismissed the subject with the thought that it was a peculiar weakness of the yellow race only to find themselves entangled in the meshes of the opium traffic. In 1906 an Episcopal bishop appealed to Pres. Roosevelt and an investigation of the conditions in America caused a wave of horror. In 1909 was held the first World Conference on the Control of Opium and in 1914 the Harrison Narcotic Act was passed by the U. S. Congress. G. O.

Pepper—Red, White, Black. B. THEODORE. *Pract. Home Econ.*, **9**, 12 (Jan., 1931).—It was the desire for pepper among other things which led to the discovery of America.

Black pepper is the dried ground fruit of *Peper Nigrum*. The fruit grows in thick clusters on a branch-like projection from a common stalk making a pretty plant. The small berries are dried, the fleshy outer portions shriveling, turning black, and becoming hard and brittle. Removing the skin before grinding gives white pepper, if unremoved gives black.

Red, cayenne, and paprika pepper come from the capsicum plant. They are low-growing plants set in rows. Red pepper is the powdered ripe pod, both flesh and seeds of any variety of the species capsicum. Cayenne is distinguished from red in that it is obtained only from small fruited capsicums with narrow red pods. It is made both by grinding the dry pods and by mixing this with yeast, flour, and water, making into cakes and baking hard.

Paprika is the product of the pimento type of pepper, aromatic, sweet, mild, and of a delicious unusual flavor. The ripe pimento is roasted until the skin may be easily removed, the skin removed, the pimento is cored, stemmed, and packed in cans. J. W. H.

The Story of Anesthesia. J. H. EVANS. *Hygeia*, **8**, 1014–7, 1128–31 (Nov., Dec., 1930).—Doctor Crawford W. Long, of Athens, Ga., was the first practicing physician to discover that the pain of a surgical operation can be eliminated by the inhalation of ether and to use it for that purpose. His first operation under ether was in 1842 and the bill for this was the full sum of $2.25 of which $0.25 was for sulfuric ether.

In 1884 a dentist, Horace Wells, of Hartford, Conn., discovered the anesthetic property of nitrous oxide, often called laughing gas. He used it for the painless extraction of teeth. His attempt to use it for a prolonged surgical operation failed for he had not learned, as surgeons now know, that it must be mixed in the proper proportions with oxygen for such work.

In 1846 a graduate dentist, at the time a sophomore in the Harvard Medical College, by the name of William T. G. Morton independently discovered the anesthetic property of ether. On October 16th of that year he gave a successful demonstration of ether anesthesia before his professors and classmates.

Other inhalation anesthetics since brought into use are: chloroform, ethyl chloride, and ethylene. The last of these has been known only seven years. Local anesthetics have, since Doctor Keller's introduction of cocaine in 1884, more than kept pace with the general anesthetics. Cocaine, however, has given way to novocain and urea quinine hydrochloride which are much less toxic than cocaine.

What is slowly coming to be recognized by the lay public is that the administrator of the anesthetic is more important to the welfare of the patient of the operating table than is the kind of anesthetic used. This welfare concerns the patient both while under operation and when in the process of recovering from the shock and drain upon his physical reserve.

Ether seems to be the most successful in achieving complete relaxation. Nitrous is more agreeable to take, is non-irritant, and in general disturbs the chemistry of the body less than does ether. It costs more to administer and requires a more skilled anesthetist.

Ethylene is growing in favor and is becoming a close competitor with nitrous oxide. This is used with oxygen much as is nitrous oxide. Chloroform has never been very widely used in America as an anesthetic. A new rectal anesthetic, tribromethyl alcohol, is the most recent addition to the list. B. C. H.

Observations and Notes on the Effect of Methanol Antifreeze on Health. R. R. SAYERS and W. P. YANT. *Ind. Eng. Chem., News Ed.*, **8,** 4–5 (Dec. 10, 1930).—Although the investigation, being conducted by the Bureau of Mines, will not be completed for several months, the findings so far which include exposure in four plants indicates that there is no hazard to health from the reasonable use of methanol for antifreeze purposes. The evidence that methanol poisoning has been caused by absorption through the skin is rare and inconclusive. Continued exposure to high concentrations will cause serious poisoning. If taken into the stomach as little as two ounces will cause serious poisoning, blindness, and possible death. G. W. S.

The Effects of Continued Administration of Iodide. *J. Am. Med. Assoc.*, **95,** 1916–7 (Dec. 20, 1930).—Reports on the value of administration of iodide are conflicting. Earlier workers have claimed that there were produced increased growth of pigs, milk secretion of cows, etc. when iodide was fed. Mitchell and co-workers (Ill. Agric. Exp. Sta.) deny that iodide in diet favors increased growth of pigs and chickens. But experimental conditions in two sets of investigations were different and it seems necessary for more work to be done before the question can be considered as settled. S. A. L.

The Vitamin A of Butter. *J. Am. Med. Assoc.*, **95,** 1978–9 (Dec. 27, 1930).—Butter has been considered superior to oleomargarine because the former is richer in vitamin A. It appears, however, that butter substitutes may be enriched in vitamin A by including carotin (carotene) with which the vitamin appears to be associated. S. A. L.

SCIENTIFIC REVIEWS AND BIBLIOGRAPHIES

The Progress of Organic Chemistry 1924–1928. IV. Heterocyclic Series. E. LEHMANN. *Z. angew. Chem.*, **43,** 1061–70 (Dec. 6, 1930); 1092–7 (Dec. 13, 1930).—*A. Penta-Rings:* 1. Furan Group; 2. Thiophene Group; 3. Pyrrol Group: (*a*) Monopyrrol, (*b*) Polypyrrol, (*c*) Porphrine, (*d*) Benzopyrrol, Indole, Carbazol; 4. Azol Group: (*a*) Pyrazol, (*b*) Imidazol, (*c*) Triazol, (*d*) Tetrazol, (*e*) Oxazol, (*f*) Oxdiazol, (*g*) Thiazol, (*h*) Thiodiaol. *B. Hexa-Rings:* 1. Pyran Group: (*a*) Pyrillium Compounds and Pyrane, (*b*) Pyrone and Cumarine, (*c*) Flavone, (*d*) Thiopyrane; 2. Pyridine Group; 3. Chinoline and Isochinoline Group: (*a*) Chinoline, (*b*) Isochinoline, (*c*) Acridine, (*d*) Naphthypyridine, (*e*) Naphthyridine, (*f*) Alkaloids: General Considerations, Pyridine Alkaloids, Chinoline, and Isochinoline Alkaloids. L. S.

The Development of the Organic Elementary Analysis. J. V. DUBSKY. *Chem. Weekblad*, **28,** 46–52 (Jan. 17, 1931).—The need of such methods is seen in some cases in the minute amount of material available for investigation and analysis. To illustrate, Willstätter obtained 2.6 g. of yellow pigment from 6000 egg yolks and Jansen and Donath isolated 100 mg. anti beri-beri vitamin, $C_6H_{10}ON_2,HCl$, from 300 kg. of wheat flour (Semmeln).

The article gives a résumé of the investigations that have had to do with modification and improvements in microanalysis from Pregl's original articles in 1911 to 1930. F. B. D.

Present Status of Theory and Experiment as to Atomic Disintegration and Atomic Synthesis. See this title on page 737.

Methods for the Determination of the Absolute Potentials. J. BILLITER. *Trans. Am. Electrochem. Soc.*, **57,** 351–60 (1930).—A review of the various methods for the determination of the absolute potentials. The new method of Bennewitz is recommended as being most trustworthy. It assigns to the normal hydrogen electrode a potential of +0.475 volt instead of the older value of −0.277 volt. E. R. W.

Electrochemistry. M. DEK. THOMPSON. *Rep. New Eng. Assoc. Chem. Teachers*, **32,** 78–83 (Jan., 1931).—A brief summary of the contributions of Galvani, Volta, Nicholson, and Carlisle to electrochemistry forms the introduction to this article. A description of an interesting model to illustrate conduction of electricity is included. The question of why some metals cannot be deposited from aqueous solution is answered. Descriptions of the uses of electrolysis follow. O. C.

Elementary Cellulose Chemistry. C. E. MULLIN. *Textile Colorist*, **52,** 838–41 (Dec., 1930).—Review and discussion of chemical and physical structure of cellulose on the basis of present-day knowledge with special reference to cotton, mercerized cotton, and rayon. E. L. C.

The New Ice Age. L. BAXTER. *Golden Book Mag.*, **13,** 83–8 (Jan., 1931).—This is a history of methods of preserving foods, with particular attention to the development of refrigeration, from earliest records down to the latest mechanical, automatic refrigerator. E. L. C.

Pre-Modern Dyeing. See this title on page 747.

History and Development of Liquefaction of Gases. W. L. BESSELMAN. *Hormone,* **4,** 193–7 (Dec., 1930).—The article consists of a review of the literature on the subject. R. L. H.

History and Development of the Modern Yeast Industry. C. N. FREY. *Ind. Eng. Chem.* **22,** 1154–62 (Nov., 1930).—The history is divided into several distinct periods: (1) Fermentation in Ancient Times showing that the Egyptians, Babylonians, Greeks, Romans, Jews were well acquainted with the art. (2) The Middle Ages, with the development of baking and brewing on a larger scale. (3) The Period before Pasteur, following the discovery of bacteria by Leeuwenhoeck in 1685 saw many improvements in the brewing and baking industries and the use of compressed yeast. Ludersdorff investigated the nature of the malt, regulated acidity to prevent contamination and promote growth, greatly influencing the later work of Liebig, Pasteur, and Mitscherlich. Heat and refrigeration were used. (4) Scientific Period. Early in the 19th century acetic, lactic, alcoholic, and putrefactive fermentation were recognized. Lavoisier in 1789 made the first quantitative investigation in the products of fermentation. Many theories were advanced and contributions made, the most important being by Pasteur in 1857, who laid the foundation for all later work. In 1896 it was shown definitely by Buchner that fermentation is caused by an enzyme secreted by the yeast cell. Methods of preparing pure cultures were evolved. (5) Modern Period of Compressed Yeast Manufacture, scientific control, large-scale production, and distribution. (6) Uses of Yeast. Present production in United States is about 230 million pounds annually. In addition to baking and brewing it has uses depending on its vitamin content. Other uses depend on its protein content. There are plants equipped to produce 300 thousand pounds daily, which in protein content is equal to that of five hundred 1000-pound steers, a fact which might be of value in a national emergency. In addition it finds use in production of invertase, nucleic acid, glycerol, certain plastics, CO_2 production, sewage disposal, and certain medicinal uses. D. C. L.

Development of the Butyl-Acetonic Fermentation Industry. See this title on page 740.

HISTORICAL AND BIOGRAPHICAL

American Contemporaries. Samuel Avery. F. W. UPSON. *Ind. Eng. Chem.*, **22,** 681 (June, 1930).—Dr. Avery is chancellor emeritus of the University of Nebraska and professor of research in chemistry. An appreciation and portrait. D. C. L.

American Contemporaries. Francis Perry Dunnington. C. L. REESE. *Ind. Eng. Chem.*, **22,** 1408–9 (Dec., 1930).—Dr. Dunnington succeeded John W. Mallet as professor of chemistry at the University of Virginia in 1884, which position he held until recently. Portrait. D. C. L.

American Contemporaries. Walter Louis Jennings. L. V. QUIGLEY. *Ind. Eng. Chem.*, **23,** 244–5 (Feb., 1931).—Dr. Jennings, teacher and scholar, is head of the chemistry department of Worcester Polytechnic Institute. Portrait. D. C. L.

American Contemporaries. Moses Gomberg. A. H. WHITE. *Ind. Eng. Chem.*, **23,** 116–7 (Jan., 1931).—Dr. Gomberg is professor of organic chemistry at the University of Michigan and is the present president of the American Chemical Society. Portrait. D. C. L.

Obituary of Dr. Ellwood Hendrick. H. E. ARMSTRONG. *Nature,* **127,** 28–9 (Jan. 3, 1931).—This is a very interesting and noteworthy account of Dr. Hendrick, written by the one Englishman who could understand and appreciate a man with the interests and abilities of the late curator of the Chandler Museum at Columbia. F. B. D.

Joseph Achille Le Bel. OBIT. *J. Chem. Soc.* (London), Dec., **1930,** 2789.—Born January 21, 1847. Died August 6, 1930. Holds an honor position in the history of science as one of those eminent French natural philosophers who discovered and worked out the earlier consequences of optical rotatory power. The theory of the asymmetric carbon atom was put forth independently and simultaneously by van't Hoff and Le Bel. He was the first to separate an optically active component from the synthetic mixture of the two mirror image components of a compound containing an asymmetric carbon atom.

His personal characteristics are also described. J. W. H.

In Memoriam: Henry Leffmann, 1847–1930. I. GRIFFITH. *Am. J. Pharm.*, **103,** 1–2 (Jan., 1931).—Mr. Leffmann was a man who served science for nearly threescore years and ten. He was known the world over for his researches in chemistry and for his contributions to scientific literature. G. O.

An Obituary of Alfred Moritz Mond (The Right Honorable Lord Melchett, P.C., F.R.S.), 1868–1930. E. F. ARMSTRONG. *Nature*, **127,** 63–4 (Jan. 10, 1931).—The subject of this notice was a son of a famous chemist, Dr. Ludwig Mond. He was educated for the bar and then entered politics. "He was a politician, a leader of industry, and an empire builder." England was fortunate in having as a representative of industry in Parliament a man who was familiar with the chemical needs and resources of the Empire, an unusual combination which was of enormous assistance to that country in the last few years, and his death was a very distinct loss to the development of science in England. F. B. D.

An Appreciation of the Life and Work of Professor W. H. Perkin. W. N. HAWORTH. *Proceedings of the Chemical Society, J. Chem. Soc.*, Oct., **1930,** 79–87; *cf.* J. CHEM. EDUC., **8,** 384 (Feb., 1931).—The address of Prof. Haworth and a reproduction of the Perkin Memorial Plaque presented to the Chemical Society Oct. 16, 1930. J. W. H.

Fritz Pregl. (1) *Science*, **72,** 645 (Dec. 26, 1930). Obituary; (2) *Nature*, **127,** 135–6 (Jan. 24, 1931). Obituary; (3) *News Ed., Ind. Eng. Chem.*, **9,** 11 (Jan. 10, 1931). Obituary; (4) *Tagespost*, No. 243, p. 7 (Sept. 3, 1929). Felicitations on the 60th birthday of Pregl; (5) *Mikrochemie*, No. 56 (1923). Account of Pregl's life and work in connection with the Nobel Award in chemistry for 1923; (6) *Les Prix Nobel en 1923*, P. A. Norstedt & Söner, Stockholm, Sweden, **1924,** pp. 82–4, biographical and portrait; (7) *Les Conférences Nobel*, P. A. Norstedt & Söner, Stockholm, Sweden, **1924,** 7 pp. The address delivered by Pregl in Stockholm, Dec. 11, 1923, on the occasion of the award of the Nobel prize for chemistry. This address includes the story of the origin, development, and the results of the quantitative organic microanalysis devised by Pregl. M. W. G.

Fritz Pregl. R. STREBINGER. *Chem.-Ztg.*, **55,** 29–30 (Jan. 10, 1931).—An account of the work of Pregl, the Austrian winner of the Nobel prize in chemistry in 1923. Pregl died December 13, 1930. L. S.

Dr. Fritz Pregl. OBIT. *Nature*, **127,** 135–6 (Jan. 24, 1931).—An obituary of Dr. Fritz Pregl, who died Dec. 13, 1930, at sixty-one.

An account is given of Dr. Pregl's services in the development of microanalysis which began in the year 1911. For this classic investigation he was awarded the Nobel prize in 1923. In his laboratory at Graz have been trained over 300 chemists and biochemists in these exact methods. F. B. D.

Sir Ernest Rutherford. See **New Year's Honor List of the Royal Society** on page 749.

Prof. Frantisek Wald. B. BRAUNER. *Nature*, **127,** 64–5 (Jan. 10, 1931).—Obituary notice. This prominent Czech chemist died October 19. F. B. D.

Pre-Modern Dyeing. J. F. SPRINGER. *Textile Colorist*, **52,** 834–7 (Dec., 1930).—This is the fourth article of an interesting series giving a complete history of dyeing methods, materials and equipment from the earliest historical references. Excellent illustrations from old prints. E. L. C.

The Early History of Meissen Porcelain. L. S. FOSTER. *Rep. New Eng. Assoc. Chem. Teachers*, **32,** 68–71 (Jan., 1931).—An interesting account is given of the development of the highly technical manufacture of porcelain by the Chinese at some early period after the beginning of the Christian Era and by the Europeans in the eighteenth century. The work is discussed of Böttger and Tschirnhaus at Dresden from 1701–1718, when a runaway workman carried the ideas to Vienna. From that city the story spread and soon there were many other plants established. O. C.

The Story of Anesthesia. See this title on page 744.

History and Development of the Modern Yeast Industry. See this title on page 746.

EDUCATIONAL MEASUREMENTS AND DATA

Is the Heavy Schedule an Incentive to Greater Effort? H. C. LEHMAN AND S. M. STOKE. *Sch. & Soc.*, **32,** 767–71 (Dec. 6, 1930).—This article contains the findings which resulted from a study made of the problem of permitting certain students to carry more than the usual number of hours per week, a problem which is continually confronting high-school and college authorities.

These requests come usually from the student who is capable of undertaking an

additional load and because the undertaking is his own choice, his attitude toward it is naturally a favorable one. "Those students do most who have most to do," says the writer and he refers to what Wm. James said years ago; *i. e.*, that everyone possesses hidden reserves of untapped energy; that one means of tapping these reserves is to undertake tasks that are too difficult to be mastered by ordinary effort. K. S. H.

Statistics of Registration in American Universities and Colleges, 1930. D. R. WALTERS. *Sch. & Soc.*, **32**, 787–98 (Dec. 13, 1930).—Over 400 institutions are tabulated, with the number of their enrolment and teaching staff. By some 60% of these institutions, a decided upward trend is shown in attendance over the past few years, despite the depression the country has been experiencing. Faith in higher education, along with a lack of business and industrial openings, are given as the probable explanation of such increases during hard times.

Those institutions having the ten largest liberal arts enrolments are given, with the registration of each; the institutions with the five largest enrolments for men undergraduates, and the coeducational universities with the largest registration for women undergraduates, are given. The enrolments of the technical institutions; law, medical, and non-professional schools are discussed—some in more or less detail. K. S. H.

Football Success and College Enrolment. G. W. GORRELL. *Sch. & Soc.*, **32**, 841–2 (Dec. 20, 1930).—Referring to two recently published articles on college football, the writer claims that the idea that success in football results in increased enrolment, is without any adequate foundation. Data secured from ten universities comprising the Western Conference and from eight Ohio Colleges, and extending over a period of twenty years (1905–24) indicated that any annual increase appeared in no way to be influenced by the successful and unsuccessful football years of the institutions.

From his findings, the writer feels that the high-school graduate chooses his college regardless of its football success. K. S. H.

THE PHILOSOPHY OF EDUCATION

Why Adult Education? C. H. JUDD. *Sch. & Soc.*, **32**, 743–50 (Dec. 6, 1930).—Continued renewing of one's intellectual outlook is necessary if one is to keep abreast of the times. Hence, adult education is essential, but must be of a different type than the elementary. The idea that there can be no education without the formality of the classroom and all that goes with it, has been a drawback. Likewise, the attitude of the learned class toward popularly written books has been a handicap. Books supply adults with much of their intellectual material—hence the material must be suitable and attractively presented. "Reading is an art and must be kept alive through practice."

Climaxing the other interfering factors is the one that adult education is not free, and he who would improve and enlarge his knowledge must pay for the privilege. For the good of communities, the proper training of the citizens is essential. Consequently, the duty of the state should not end with the prescribed preliminary education of the public and high schools, but should go further, making available the resources needed for free adult education. K. S. H.

PROFESSIONAL

The Ideal Teacher. G. H. PALMER. *J. Natl. Educ. Assoc.*, **20**, 1–8 (Jan., 1931).—The four qualifications of a good teacher are: first, he must have an aptitude for vicariousness; second, an already accumulated wealth; third, an ability to invigorate life through knowledge; and fourth, a readiness to be forgotten. These qualifications are discussed at length. A. E. C.

Personal Relations of Teachers with Fellow Members of the Faculty. J. W. BARKER. *J. Eng. Educ.*, **21**, 265–9 (Dec., 1930).—An educational institution is and must be a democratic institution. However, some work must be delegated to committees to determine the general lines of attack. In committee meetings there should be free discussion, both pro and con, and when the vote is taken each member of the committee should support the decision reached. The same should apply to faculty meetings. One question asked concerning army officers could be applied to faculty men; "Properly constituted authority having decided on a particular line of attack, does he willingly and loyally coöperate to carry out that line of attack?" The social life of the faculty member should result in; (*a*) a broadening effect, one on the other, (*b*) overcoming superiority complex so often obtained as a result of contact with immature minds, and (*c*) fostering the morale of the staff to withstand the raids of industry by making university life attractive. The faculty club is suggested as a method of attaining these results. H. T. B.

Personal Relations of Teachers with Students. See this title on page 737.

Code of Ethics, The American Institute of Chemists. See pp. 731–3.

The Employment of Teachers. W. C. BAGLEY. *Sch. & Soc.*, **32,** 841 (Dec. 20, 1930).—A temporary emergency fund created through the efforts of the N.E.A. is being used to provide compensation and temporary educational work for those who are badly in need of assistance.

It is suggested that every state association establish a permanent "welfare fund" to meet crises when they present themselves. K. S. H.

Showing Cadets How in Seattle. F. C. FOSTER. *Wash. Educ. J.*, **10,** 112 (Dec., 1930).—To give adequate teacher's training, University of Washington students taking the teacher's course are given practice in the classrooms of the Seattle schools under the supervision of selected teachers. Thereby, the student is given a real public-school situation.

Prerequisites for this training are three courses, one in secondary education, one in general methods, and one in the analysis of the technic for teaching his special subject.

The benefits of the practice-teaching are twofold. The student gains practical experience and the teacher is given assistance in grading papers and the individual student is given additional help. Group conferences are held for students cadeting in the same field and also conferences are held between teachers and university supervisors for the purpose of improving the teaching of the cadet. A. E. C.

The Training of Science Teachers for Secondary Schools. See this title on page 737.

The Project Method in Research. J. MILLS. *J. Eng. Educ.*, **21,** 214–9 (Nov., 1930).—Research may be carried out according to two methods; the project method, and the broad frontal attack aimed in no particular direction. The former has been used successfully in industry, and M. believes it could be advantageously applied by academic research workers. "The project method . . . may be summarized as the method of systematizing research in which a rather definite objective is established and the research activities of a group of workers coördinated toward its accomplishment. . . The adoption of a project permits a unified and coördinated research program; it adds direction, prevents scattering of effort and rolls up ideas, methods, technics, and results with a cumulative effect like that of compound interest. The research grows and branches like a tree, with new shoots and budding problems springing from last season's growth. Its roots meanwhile reach farther and farther back into the fundamentals of the sciences upon which it depends, entering new ground, tapping new veins of knowledge and venturing into a dark unknown." There is the danger that a project may be too narrow, but in general the projects are found to require too large a variety of experience and training. Consequently some coördinating agency between workers is desirable, particularly in fields removed one from the other. It is at this juncture that the difficulty comes in the application of the project method to university research. H. T. B.

CONTEMPORARY NEWS AND COMMENTS IN CHEMISTRY AND EDUCATION

Wring Out the Old; Ring in the New. EDIT. *Am. J. Pharm.*, **103,** 3–15 (Jan., 1931).—Herewith are recorded the notable achievements in the various fields of science during the year 1930 (compiled from statistics appearing in *Science Service* and in the *J. Am. Pharm. Assoc.*) including advances in the fields of biology, chemistry, physics, medicine, pharmacy, psychology, and psychiatry, together with the awards and recognitions granted. G. O.

New Year's Honor List of the Royal Society. *Nature*, **127,** 65–6 (Jan. 10, 1931).—The New Year's Honor List, among others, contains the following name: *Baron:* Sir Ernest Rutherford, Chairman of the Advisory Council of the Committee of the Privy Council for Scientific and Industrial Research and until recently President of the Royal Society.

This event is noteworthy since it is an unusual distinction and recognition of the scientific work of this distinguished investigator in the nature of the atom.

A résumé of former presidents of the Society who have been raised to peerage is included. F. B. D.

Final Program of Division of Chemical Education, Indianapolis Meeting of the A. C. S., March 30 to April 3, 1931. See page 751.

A Science Building for a Liberal Arts College. G. M. EVANS. See page 753.

Willard Gibbs Medal for 1931 Awarded to Dr. Levene. See page 756.

William H. Nichols Medal Award for 1931 to Dr. Wilson. See page 757.

Chilean Nitrate of Soda Nitrogen Research Award to Skinner, Willis, and Wilson. See page 759.

Dr. Sidgwick at Cornell on Baker Lectureship. See page 759.

New Photographic Emulsion Aids Motion Pictures. See page 759.
Fragile Gas Molecules Rebound Unchanged from White-Hot Surface. See page 760.
Mechanical Models of Molecules Disclose Nature of Spectrum Vibrations. See page 760.
Utah Research Fellowships in Mining and Metallurgy. See page 761.
Research Fellowships and Scholarships Open at Institute of Paper Chemistry. See page 762.
New Soil Erosion Laboratories Planned. See page 762.
New Research Project on Copper at Battelle Memorial Institute. See page 762.
Third International Congress on Bituminous Coal. See page 763.
Dr. Wieland Gives Silliman Lectures at Yale. See page 763.
Professor Fowler to Lecture at University of Wisconsin. See page 764.
Industrial Chemists Make Contact with University Research through Lectures at University of Chicago. See page 764.
Dr. Riggs Addresses New York Professional Group of Alpha Chi Sigma. See page 764.
Dr. Haas Lectures at Pennsylvania State College. See page 765.
Eleventh Ohio State Educational Conference. See page 765.
The Kansas Association of Chemistry, Physics, and General Science Teachers. See page 766.
The Chemistry Teachers Club of New York. See page 766.
New Science Building for the Phillips Exeter Academy. See page 767.
Vocational Lectures for High-School Students at Syracuse University. See page 767.
Deutsche Bunsen Gesellschaft. See page 767.
Florida Section, A. C. S., Sponsors Radio Talks. See page 767.
Northeastern Section, A. C. S., Chemistry Broadcasts. See page 768.
Dr. Luckhardt Addresses Journal Society of De Paul University. See page 768.
The E. H. S. Bailey Prize in Analytical Chemistry at University of Kansas. See page 768.
Dr. Kaempffert Resigns Directorate of Museum of Science and Industry. See page 768.
National Industrial Museum Discussed by Congress. See page 769.
Thirteenth Exposition of Chemical Industries. See page 769.
North Louisiana Chemical Society. See page 770.
New Appointments by American Ceramic Society. See page 770.
Staff Changes at Mellon Institute. See page 771.
Faculty Appointments at Cooper Union. See page 771.
Edgar Fahs Smith Memorial Collection at University of Pennsylvania. See page 771.

FOREIGN CHEMICAL AND EDUCATIONAL CONDITIONS

Examination in Textile Technology. *J. Textile Inst.*, **21,** 191–2 (Dec., 1930).—Examination in general textile technology given in connection with applications for the associateship of the Textile Institute at Manchester, England. Interesting information relative to requirements of an English textile school. E. L. C.

GENERAL

Industrial Research Methods and Workers. E. R. WEIDLEIN. *J. Eng. Educ.*, **21,** 139–48 (Oct., 1930).—Chance discoveries have not contributed materially to the progress of industrial technology in the past. Industry now recognizes the methods of science as the most effective procedures known for the advancement of technology; consequently scientific investigation is an essential economic adjunct to manufacturing enterprises. A large number of industries operate research laboratories; many have established research fellowships at certain colleges and universities. The value of pure scientific research has been recognized, and a fund has been placed at the disposal of the National Research Council for that purpose. Systematic scientific research reduces the time lag in the development of an industry. Development in one field makes progress necessary in many others; *e. g.*, the automobile has induced development in the petroleum, rubber, paint, and varnish industries, etc. H. T. B.

How Wild Oil Wells Are Tamed. J. GELDERS. *Pop. Sci. Mo.*, **118,** 19–21 (Feb., 1931).—Oil wells flow because of gas or water pressure. Before a well is completed it is fitted with valves so that if it starts to flow it may be controlled. Occasionally these connections fail. In attempting to control a wild well, a heavy cap fitted with valves is placed on the casing and anchored with chains. Once in place, the valves are closed one at a time. Meanwhile, every precaution is taken to prevent fire. H. T. B.

Contemporary News in Chemistry and Education

FINAL PROGRAM OF DIVISION OF CHEMICAL EDUCATION, INDIANAPOLIS MEETING OF THE A. C. S., MARCH 30–APRIL 3, 1931

MONDAY, MARCH 30

8:00 A.M. *Breakfast Meeting of the Executive Committee.* Parlor B. Claypool Hotel.

TUESDAY, MARCH 31

9:30 A.M. Symposium on "Coöperation between Industry and Chemical Education." Assembly Room, Claypool Hotel. FRANK B. WADE, presiding.

1. "Chemical Industry and the Curriculum," ALFRED H. WHITE, University of Michigan.
2. "Coöperative Employment of Chemistry Students," W. A. HAMMOND AND D. S. HANCHETT, Antioch College.
3. "Industrial Fellowships and Scholarships," LEONARD H. CRETCHER, Mellon Institute of Industrial Research.
4. "Inspection Trips," W. T. READ, Rutgers University.
5. "Student Meetings of the Indiana Section," WM. HIGBURG, The Reilly Chemical Company.

12:00 M. *Luncheon.* $1.00. Ballroom, Columbia Club. Several short invited addresses. (High-school teachers of chemistry from Indianapolis and the vicinity will be guests of the Division.)

General Papers, Assembly Room, Claypool Hotel

2:00 P.M. W. E. BRADT AND R. D. GERWE, State College of Washington. "More Effective Individual Laboratory Instruction in General Inorganic Chemistry, III."

2:15 P.M. HARRISON HALE AND A. E. LUSSKY, University of Arkansas. "A New Method of Teaching German."

2:35 P.M. LEON S. WARD, Colorado School of Mines. "A Freshman Course in Chemistry in an Engineering College."

2:55 P.M. JACK P. MONTGOMERY, University of Alabama. "Chemical Courses in Premedical Education."

3:15 P.M. PAUL H. FALL, Hiram College. An Annual "Chem Party."

3:35 P.M. H. V. MOYER, The Ohio State University. "An Inexpensive Stirring Device for the Analytical Laboratory."

3:45 P.M. J. STANTON PIERCE, Georgetown College. "The Use of Anion Group Tests in Teaching Qualitative Analysis."

4:00 P.M. HAROLD C. HODGE, Ottawa University. "A Study of the Reliability of Examination Marks in General Chemistry."

5:00 P.M. *Meeting of Editors,* JOURNAL OF CHEMICAL EDUCATION and *The Chemistry Leaflet.* Claypool Hotel.

6:00 P.M. *Editors' Dinner.* Parlor T, Claypool Hotel.

WEDNESDAY, APRIL 1

9:00 A.M. *Meeting of the Senate of Chemical Education,* Assembly Room, Claypool Hotel

11:00 A.M. *Meetings of Standing Committees,* Assembly Room, Claypool Hotel.

General Papers, Riley Room, Claypool Hotel

2:00 P.M. ALEXANDER SILVERMAN, University of Pittsburgh. "Motion Pictures of the Tenth International Union of Pure and Applied Chemistry, Liége, Belgium, September, 1930."

2:25 P.M. NEIL E. GORDON AND WM. E. TROUT, JR., The Johns Hopkins University. "The Adaptation Method of Teaching Chemistry."

3:00 P.M. MARTIN KILPATRICK, JR., University of Pennsylvania. "A Freshman Experiment. The Reaction of Magnesium with Acids."

3:20 P.M. E. GEBAUER-FUELNEGG AND ARTHUR I. KENDALL, Northwestern University Medical School. "Electrodialysis with Simple Apparatus."

3:35 P.M. EWING C. SCOTT, Sweet Briar College. "Atomic Models for Use in Teaching Inorganic Chemistry."

3:50 P.M. DRULEY PARKER, Shortridge (Indianapolis) High School. "Segregation of High-School Chemistry Pupils."

4:10 P.M. ROYCE HAROLD LEROY, Doane College. "A Modified Periodic Classification of Elements Adapted to the Teaching of Elementary Chemistry."

4:30 P.M. WASHINGTON PLATT, The Borden Company, AND R. A. BAKER, College of the City of New York. "The Scientific Hunch."

4:40 P.M. D. H. KILLEFER, Dry Ice Equipment Corporation. "The Placement of Chemists."

5:00 P.M. Business Meeting of the Division, Riley Room, Claypool Hotel.

THURSDAY, APRIL 2

8:15 A.M. *Excursion to Bloomington, Indiana.* Sponsored by Indiana University and the limestone interests. Complimentary to invited guests and registered members (wives included) of the Division of Chemical Education.

1. Round-trip transportation from Indianapolis to Bloomington. Motor buses will leave from Greyhound Station at 8:15 A.M.
2. Inspection of the Skinner Stone Mill of the Bloomington Limestone Company at Clear Creek.
3. Visit to the Oolitic Limestone Quarry of the Indiana Limestone Company near Clear Creek.
4. Motor bus to the Indiana University Campus.
5. Complimentary luncheon by the University in the Commons, 12:15 P.M.
6. Academic Procession from the West Parlors of the Student Building to the Chemistry Building, 1:30 P.M.
7. Dedication Exercises at 1:45 P.M. followed by inspection of the building and a tea in the Chemistry Library.
8. Motor buses for Indianapolis leave from the Chemistry Building at 4:00 P.M., arriving at Indianapolis Union Station at 5:40 P.M.; at Bus Station at 5:45 P.M.

Dedication Exercises

THURSDAY, APRIL 2, at 1:45 P.M. in the Auditorium of the Chemistry Building.

1. "America," directed by EDWARD BAILEY BIRGE, Professor of Music, Indiana University.
2. Delivery of the Master-Key of the Chemistry Building to the President of the Board of Trustees. ROBERT FROST DAGGETT, Architect.
3. Presentation of the Key to the President of the University. JAMES

WILLIAM FESLER, President of the Board of Trustees of Indiana University.

4. Acceptance of the Key. WILLIAM LOWE BRYAN, President of Indiana University.
5. Introduction of the guest speakers. JOHN NESBIT SWAN, Chairman of the Division of Chemical Education, A. C. S.
6. Address. "The Production of Chemists by the Universities." FRANK CLIFFORD WHITMORE, Dean of the School of Chemistry and Physics, Pennsylvania State College.
7. Address. "The Importance of Research to Industry." LAWRENCE V. REDMAN, Vice-President and Director of Research, Bakelite Corporation, and President-Elect of the A. C. S.
8. Acknowledgments and presentation of a portrait of Thomas Carlton Van Nuys, first full-time professor of chemistry at Indiana. ROBERT EDWARD LYONS, head of the Department of Chemistry, Indiana University.
9. Presentation to the President, by the Dean of the Graduate School, of six former students of chemistry at Indiana, as candidates for honorary degrees; and the conferring of the degrees by the President.
10. Prayer and Benediction. REV. A. ELLISTON COLE, Rector of Trinity Episcopal Church.
11. "Indiana," Indiana University Men Singers. Directed by DOUGLAS D. NYE, Asst. Professor of Music, Indiana University.
12. Inspection of the laboratories. Staff and Graduate-Student Guides.
13. Tea in the Chemistry Library. Ladies of the University and the Department assisting.

FRIDAY, APRIL 3

8:30 A.M. *Optional Inspection Trips.*

A limited number of rooms in local fraternity houses will be provided during Convention week for visiting chemistry students only. Those who wish to avail themselves of these accommodations should correspond at once with the *Local Secretary*.

JOHN R. KUEBLER, *Local Secretary*
5503 E. Washington St.
Indianapolis, Ind.

R. A. BAKER, *Secretary*
17 Lexington Ave.
New York, N. Y.

A SCIENCE BUILDING FOR A LIBERAL ARTS COLLEGE

GREGG M. EVANS, YANKTON COLLEGE, YANKTON, SOUTH DAKOTA

On September 12, 1930, there was dedicated at Yankton College, Forbes Hall of Science, the gift of MR. and MRS. FRANK B. FORBES. The dedication program comprised an afternoon and evening session. The former included the description of the planning and construction of the building, presentation of the keys by Mr. Forbes and acceptance for the Board of Trustees, a ritual and prayer of dedication, and felicitations. In the evening a short musical program in the new auditorium was followed by an address by DR. L. E. AKELEY, dean of the College of Engineering, University of South Dakota, on "The Place of Science in a Liberal Arts College,"[1] after which the building was thrown open to the public for inspection.

The Building

The building is T-shaped and the three wings are devoted to biological science,

[1] *South Dakota Educ. Assoc. J.*, **6**, 233–6 (Dec., 1930).

auditorium, and physical science. As it is over two hundred feet long, division in this manner effected a material saving in plumbing and considerable convenience in service arrangements. The north wing was chosen for biology so as to have the maximum of proper daylight for microscopic work, and contains units for zoölogy, botany, physiology, and psychology, each containing laboratories, lecture rooms, and an office and laboratory for each instructor. In addition to the auditorium and its complete stage and projection equipment, the central wing contains the work rooms, scenery construction rooms, etc., for the instruction in dramatics. The south wing houses chemistry, physics, and geology. The frame of the building is of concrete and steel, the outside bearing walls of brick and tile, and the partitions of tile or plaster on metal lath, with a view to the possibility of future changes. Heat is obtained from the school's central heating plant, and high-pressure steam is delivered direct to the laboratories where needed. The walls in the south wing are finished in light green, the north wing in tan, and the auditorium in redwood paneling with acoustical plaster ceiling colored to match. The woodwork elsewhere is of dark oak, as are the laboratory desks. The floors are of mastic. Alberene stone was used for chemistry table tops, black acid-proof wood for others.

Supply System

An inclined drive is provided so that trucks may be driven down to, and if desired into, a receiving room in the south end of the basement. From this biological supplies go *via* the corridor to the north end and those for chemistry to the main chemistry store. A small room for acid dilution is provided with its own exhaust fan. A dumb-waiter in each end serves the floors above.

Electrical System

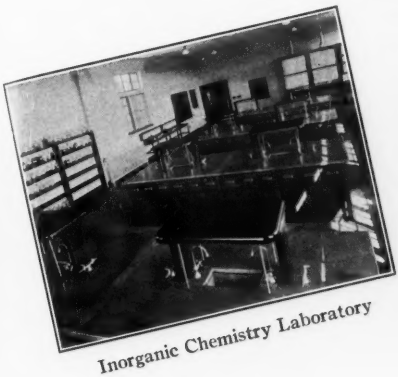
A transformer vault was constructed at the stage end of the auditorium wing. Into this three-phase power is brought at 2300 volts. It is planned to distribute all power for the campus underground from this vault. A main switchboard just within the building proper distributes to sub-panels over the building. Lighting in the building is planned for at least eight-foot candles on the working surface. In the battery room in the south wing are placed a 24-volt storage battery, a 110-volt D. C. motor generator, a charging and control panel, and a jack panel enabling the operator to place current from the battery in 2-volt steps, from the generator, or 110-volt A. C. on any of the outside circuits connected with the panel. From this and another panel in the main lecture room this variety of voltage is available at any of some forty 20-ampere outlets in this wing.

Physical Science Wing

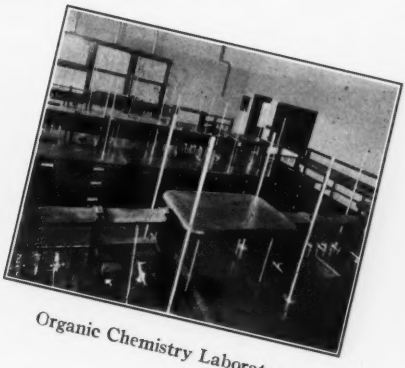
Two basic principles were kept in mind in planning. The first was to bring chemistry fume hoods to the students' tables, using wall hoods only where special needs such as hydrogen sulfide distribution, steam baths, etc., arose. The table hoods used were selected after careful investigation of the types available, and have certainly fulfilled all expectations. The second principle was to have all plumbing readily accessible. Lead pipes drop through traps for each sink to alloy iron horizontals suspended in the open from the ceiling below. These are provided with a multiplicity of clean-outs. On the ground floor few sinks are concerned and the pipes were put in the floor.

The ground floor contains laboratories for geology and physics, one of the latter so arranged that it can be completely darkened, recitation room, instructors' offices and laboratories, the receiving, battery, and store rooms mentioned above, and a work shop containing glass-blowing table, machinists' and carpenters' benches, air compressor, etc. The first floor includes the laboratories for physical chemistry and quantitative analysis, with balance room, an assistants' office and labora-

Entrance



Inorganic Chemistry Laboratory



Organic Chemistry Laboratory

FORBES HALL OF SCIENCE

tory, and the main chemistry lecture room. The second floor contains the general inorganic and organic laboratories, instructor's office and laboratory, and the supply room. The latter opens into the inorganic laboratory, obviating any necessity for students leaving that room. One feature in the organic laboratory, which the author had not seen used prior to the planning of this building, is the use of a 19-mm. rod set in the table at each desk, as a foundation for the somewhat top-heavy set-ups which are frequently necessary in this type of work. A small laboratory on this floor and one on the first provide opportunity for advanced courses or research. The attic contains the blowers and motors for the fume hoods and in a small room the steam-heated water still and storage tank. Distilled water, steam, with mixers for hot water, compressed air, gas, and electricity at any desired voltage, are available wherever needed.

Acknowledgments

The cost of the building complete is about $325,000. The fine attitude of the donors can best be expressed in the words used by Mr. Forbes in presenting the keys: "Mrs. Forbes and myself share.....the belief that the possession of money brings with it no great pleasure or satisfaction aside from the ability it gives one to present it to worthy causes." From the beginning their sole desire has been to have only the best, and the building represents the efforts of those who planned it to fulfil that desire. To the architect, MR. G. G. ELMSLIE of Chicago, the writer desires to express his appreciation of the continuous coöperation that those who are to use the building have had in attaining their desires. Many people have helped with suggestions, but special thanks are due DR. RAYMOND F. MILLER of the college of Emporia, Kansas, for suggestions incorporated in the physics section of the building, and to MR. ELMER L. ANDERSEN of Minneapolis, Minnesota, for his very great help in working out the details.

WILLARD GIBBS MEDAL FOR 1931 AWARDED TO DR. LEVENE

The Willard Gibbs Medal, established in 1911 by William A. Converse, and awarded annually by the Chicago section of the American Chemical Society for original and valuable contributions to pure or applied chemistry, has been given this year to PHOEBUS A. LEVENE, of the Rockefeller Institute, "as the outstanding American worker in the application of organic chemistry to biological problems." The following distinguished scientists have preceded Dr. Levene as recipients of this honor: SVANTE ARRHENIUS, THEODORE W. RICHARDS, LEO H. BAEKELAND, IRA REMSEN, ARTHUR A. NOYES, WILLIS R. WHITNEY, EDWARD W. MORLEY, WILLIAM M. BURTON, WILLIAM A. NOYES, F. G. COTTRELL, MARIE CURIE, JULIUS STIEG-

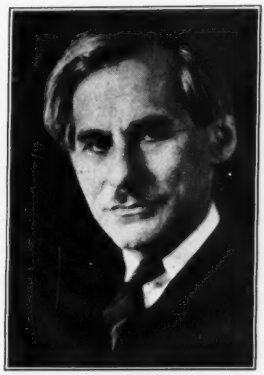
Chemical Bulletin

FACSIMILE OF THE WILLARD GIBBS MEDAL

LITZ, GILBERT N. LEWIS, MOSES GOMBERG, JAMES C. IRVINE, JOHN J. ABEL, WILLIAM D. HARKINS, CLAUDE S. HUDSON, and IRVING LANGMUIR.

The *News Edition, Industrial and Engineering Chemistry*, gives the following account of the 1931 medalist's career:

Dr. Levene is noted for his studies in nucleic acids, amino sugars, lecithins, cephalins, fatty acids, cerebrosides, inor-



Ind. Eng. Chem.

ganic esters of sugars, thiosugars in yeasts, hydroxy acids, and amino acids, as well as for his work in stereochemistry as illustrated by the configuration of sugars in the Walden inversion.

Dr. Levene was born in Russia in 1869. He received his secondary education in the classical gymnasium of St. Petersburg and the degree of doctor of medicine from the Imperial Military Academy in 1891. While a student he participated in the work of A. DIANIN on the condensation of phenols with aldehydes and with ketones.

Dr. Levene came to America in 1893. For a short time he practiced medicine, and then entered the School of Mines of Columbia University as a special student, pursuing at the same time research in biological chemistry in the laboratory of J. J. CURTIS of the Columbia Medical School. Later he worked with E. DRECHSEL in Berne, with A. KOSSEL in Marburg, with PROFESSOR HÖFER in Munich, and with E. FISCHER in Berlin. From 1896 to 1905 he was associate in chemistry in the State Pathological Institute of New York. In 1905–06 he was Herter lecturer in New York University. In 1905 he entered the Rockefeller Institute for Medical Research as research chemist, and in 1907 was made a member of the institute.

Dr. Levene is a member of the American Chemical Society, National Academy of Sciences, American Philosophical Society, Society of Biological Chemists, American Society of Naturalists, Society of Experimental Medicine and Biology, Royal Society of Science of Upsala, Deutsche Chemische Gesellschaft, Société de Chimie Biologique, and Société Chimique de France. He is an associate member of Société Royale des Sciences Medicales et Naturelles de Bruxelles, and an honorary member of Phi Lambda Upsilon. He is the author of papers on proteins, nucleins, carbohydrates, lipoids, the problem of stereochemistry, and of a monograph, "Hexosamines and Mucroproteins," published in 1925.

WILLIAM H. NICHOLS MEDAL AWARD FOR 1931 TO DR. WILSON

Award of the William H. Nichols Medal of the New York Section of the A. C. S. for 1931 to DR. JOHN ARTHUR WILSON of Milwaukee, Wisconsin, is announced. The award, bestowed for outstanding achievement in colloid chemistry, applied particularly to leather and sanitation, was presented to Dr. Wilson at a national gathering of scientists in New York on March 13th.

The Nichols Medal, one of the most distinguished of American honors in chemical science, was established by the late DR. WILLIAM H. NICHOLS to encourage original research in chemistry. The award is determined by the research published during the preceding year which in the opinion of the jury is most original and stimulative to further research. Dr. Nichols was chairman of the board of the Allied Chemical and Dye Corporation, a charter member of the A. C. S., and a

benefactor of New York University, and other institutions.

Dr. Wilson in 1924 started the first comprehensive measurement of the properties of leather. He showed that the prognosticators who foretell weather changes by pains in their feet owed their ability to dimensional changes in the leather of their shoes with changes in relative humidity.

He showed also how the area change of leather with relative humidity could be reduced to one-third by the proper selection of tanning material. He made the first measurements of ventilating properties of leather, pointing out how leather could be made to allow perspiration to pass out from the inside of a shoe eighty per cent as fast as from a bare foot and still have the shoe water-repellent from the outside.

He measured the effect of color of a shoe upon its temperature rise in sunlight, and related the strength and stretch of leather to controllable factors. He devised methods for measuring and controlling temper, resilience, porosity, and density of leather, and organized a national committee to study the properties of leather from the standpoint of greatest comfort, utility, and economy to the ultimate user.

Dr. Wilson has made extensive additions to the literature of animal skin and and its functions, indicating the variations in different animals of different ages according to location on the skin, feeding, and climatic conditions under which they live.

He named the thermostat layer of the skin and demonstrated the part it plays in keeping the body temperature constant, in colds, in making hair straight or curly, in hair turning gray, in baldness, in making pimples, and in producing effects bearing upon the properties of leather made from the skin. He contrived a technic for making fine sections and photomicrographs of skin.

Dr. Wilson developed the principles of the activated sludge process of sewage disposal that made possible the great plant at Milwaukee, called the most efficient in the world. This plant separates 100 million gallons of sewage daily into water purer than many municipal drinking waters and 100 tons daily of a dry, granular fertilizer that has been in great demand at about $20 a ton.

In collaboration with assistants, he discovered the mechanism of the process, showing the purification to be the victory of protozoa over bacteria in the presence of oxygen. The protozoa devour the bacteria and the foul products of putrefaction, finally settling out with the insoluble matter and leaving the supernatant water clear and pure. Many of the fundamental laws of colloid chemistry and the physical chemistry of the proteins were brought into play and fundamental laws of purification developed.

Dr. Wilson worked out the first practical method of dewatering activated sludge, with chemical treatment followed by vacuum filtration and drying, producing a fertilizer initially sterile and rich in nitrogen.

In 1916, with PROCTER, Dr. Wilson developed the first quantitative theory of molecular mechanism of protein swelling in electrolytes. This was followed by similar theories on adsorption, electrically charged surfaces and interfaces, and started the line of reasoning which JACQUES LOEB developed into his modern theory of colloidal behavior.

During the following fourteen years, he invented new processes and developed theories of the mechanism of the complex operations of unhairing with alkalies, sulfides, and enzymes; bating with enzymes, pickling, chrome, vegetable, and other tannages, fat-liquoring with oil emulsions, dyeing, and finishing. He worked out theories of the neutral salt effect, enzyme actions, effect of neutral salts on bacterial counts, etc., and devised many methods of analysis, including that of the scientific determination of tannin.

Dr. Wilson was born in Chicago, August 16, 1890. He attended New York University, and took post-graduate work at

the University of Leeds, England. He has been a lecturer at the University of Chicago and at Columbia University, by which he was awarded the Charles Frederick Chandler Medal in chemistry in 1928. He is president of John Arthur Wilson, Inc., of Milwaukee, and is identified with several financial enterprises.

He holds membership in numerous scientific organizations here and abroad, and has been active as a scientist in the public service. He received the honorary degree of doctor of science from Lehigh University in 1929, and is the founder of the Leather Division of the American Chemical Society. Most of Dr. Wilson's scientific work appears in about 150 scientific publications; a small amount is yet unpublished.

The chairman of the jury which made the award is DR. J. G. DAVIDSON of the Carbide and Carbon Chemicals Corporation and past president of the New York Section. Other members are DR. D. P. MORGAN, executive secretary of the New York Section, and the following past presidents of the section: DR. C. R. DOWNS, consulting chemical engineer; PROFESSOR R. R. RENSHAW, New York University; PROFESSOR ARTHUR W. THOMAS, Columbia University.

Speakers at the presentation ceremony included Professor Thomas and CLARKE E. DAVIS, production manager of the National Biscuit Company.

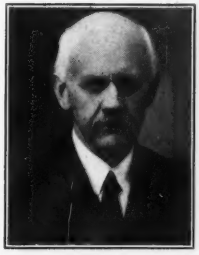
CHILEAN NITRATE OF SODA NITROGEN RESEARCH AWARD TO SKINNER, WILLIS, AND WILSON

The Chilean Nitrate of Soda Nitrogen Research Award of $5000, administered by the American Society of Agronomy, was, at the recent meeting of the society in Washington, divided equally among DR. J. J. SKINNER, senior biochemist of the Bureau of Chemistry and Soils, U. S. Department of Agriculture; PROFESSOR L. G. WILLIS, soil chemist of the North Carolina Experiment Station; and DR. JAMES K. WILSON, professor of soil technology, Cornell University.—*Science*

DR. SIDGWICK AT CORNELL ON BAKER LECTURESHIP

The George Fisher Baker Non-Resident Lecturer in Chemistry for the present university term is DR. NEVIL V. SIDGWICK of Oxford University.

Dr. Sidgwick was born in Oxford, May, 1873. He was educated at Rugby School and Christ Church, Oxford (Scholar, 1892), B.A., 1895. He studied under H. von Pechmann at Tübingen, 1899–1901, Ph.D. (Tübingen) 1901. Since 1901, he has been fellow and tutor in chemistry at Lincoln College, Oxford; demonstrator in the university laboratory, 1903–1925; university reader in chemistry from 1925 to the present. He has been a fellow of the Royal Society since 1922. Dr. Sidgwick has also served as president of the chemical section of the British Association for the Advancement of Science, Leeds Meeting, 1927; chairman of the publication committee of the Chemical Society, London, 1923–1930; and as member of the Advisory Council of the Department of Scientific and Industrial Research.



Dr. Sidgwick's scientific work has dealt chiefly with the application of physical chemistry to organic chemistry, and with valency and molecular structure. He is the author of "Organic Chemistry of Nitrogen" (1910), and "Electronic Theory of Valency" (1927).

Dr. Sidgwick will lecture this term on "Molecular Structure and the Periodic Classification."

NEW PHOTOGRAPHIC EMULSION AIDS MOTION PICTURES

From the astronomical observatory to the movie lot a new triple-fast photographic emulsion has come to make motion-picture production cheaper and more flexi-

ble. The motion-picture film introduced to the profession recently is described by the Eastman Kodak Company as "the greatest advance in motion-picture materials since the introduction of panchromatic film eighteen years ago." Its sensitive emulsion is very closely related to one prepared for astronomical photography which has been used to reduce the time required for making exposures through large telescopes. An improvement in the photographic plates used is just as effective in this case as though the telescope itself were increased in size. The super-speed panchromatic plates produced for newspaper photographers are also very similar to the new movie emulsion.

When the movies went talkie, it was necessary to banish the familiar arc lamps on account of their noise. Large incandescent lamps are used. These are rich in red light which does not register effectively on ordinary movie negative. The new supersensitive film is affected by both red and green light to a much greater extent than previous film. Camera men will now be able to "spot down" their lenses and get increased depth of focus which will allow the actors to move around with less fear of getting out of focus, or they will be able to use less light and save money.—*Science Service*

FRAGILE GAS MOLECULES REBOUND UNCHANGED FROM WHITE-HOT SURFACE

Chemical molecules can be handled very roughly without breaking them into fragments, experiments by PROFESSOR F. O. RICE and DR. HAROLD T. BYCK at The Johns Hopkins University demonstrate. Professor Rice's work gives one answer to a fundamental problem that has occupied the attention of physical chemists for twenty years: how is heat transferred from the walls of a container to the gas inside—which is continuously in motion?

Acetone molecules which ordinarily decompose at a temperature of 1000°F. into the gas methane and other products were bounced from a white-hot platinum surface at 2900°F. without change, in Professor Rice's experiments. Previously it had been assumed that a certain fraction of the molecules sit down on the surface for a while, then get up, and leave When things get this hot it seems they cannot be persuaded to stay.

Many chemical substances decompose when heated, as the amateur housewife knows from her cooking. Professor Rice has been attempting to decide whether this decomposition is due to the heat rays from the walls of the vessel enclosing the substance or to the fact that at higher temperatures the gas molecules collide more violently with each other.

In earlier experiments with PROFESSOR H. C. UREY and DR. R. N. WASHBOURNE molecules were heated but collisions between molecules were prevented by having all the molecules of gas moving in a procession through a very hot furnace. These experiments showed the heat radiation alone was unable to cause chemical change. Apparently there are also some kinds of collisions of molecules that are equally ineffective in producing chemical changes.—*Science Service*

MECHANICAL MODELS OF MOLECULES DISCLOSE NATURE OF SPECTRUM VIBRATIONS

Vibrations of steel balls and spiral springs now give science exact information on the motions occurring in actual molecules far too small to be seen. DR. C. F. KETTERING, general director of General Motors Research Laboratories, PROF. D. H. ANDREWS of The Johns Hopkins University, and L. W. SHUTTS, also of the General Motors Research Laboratories, have agreeably surprised physicists all over the world by constructing mechanical models in which the various kinds of atomic vibrations occurring in, for instance, a molecule of benzene can be visually observed. These models reproduce with exactness the light radiations or spectra from liquid benzene.

The models are constructed of steel

balls connected by spiral springs. The balls are the same relative weights as the carbon, hydrogen, or oxygen atoms they represent. The web of balls and springs is freely suspended and connected to a vibrating rod whose speed can be varied by an electric motor. At definite frequencies of vibration, which are recorded on a counter, the model takes up a characteristic motion. Those rates at which the model resonates are found to agree remarkably with the frequencies observed in light scattered by the substance.

The investigators postulated that the forces connecting the atoms in a molecule are the same as if the atoms are connected by spiral springs. These forces were imagined to lie in the chemical bonds which elementary students of chemistry represent when they write chemical formulas. A spring can either stretch or bend. Specific heat measurements previously made by Professor Andrews showed that probably the same is true of the chemical bond. Equally surprising was the further result that the elasticity or springiness of all bonds is the same no matter what atoms are joined by them.

The first model made was of benzene, a molecule consisting of six atoms of carbon and six of hydrogen, and was made rather diffidently. Definite numerical results were not expected. In constructing the model, the springs had to be strong enough so that the stretching and bending forces on the balls would be large in comparison with gravitational forces. Also the balls and springs had to be so related that the vibrations would be of a speed that could be observed by the flickering light of a stroboscope. The models were suspended by thin rubber bands, much weaker than the springs. A stroboscope permits the observation of more rapid vibrations than can be seen with the naked eye if the frequency of the flicker is brought close to the frequency of the oscillations.

A chart of the rates of vibrations was made. It was immediately recognized that the arrangement of lines was practically identical with those in the so-called Raman spectrum of benzene, which is also due to vibrations within the molecule. A simple calculation then enabled the investigators to convert the model's rates of vibrations into Raman frequencies.

The Raman spectrum is obtained by observing through a prism spectroscope the light scattered by a liquid or solid from a beam of light. Mercury arc light containing only single wave-lengths was used. The original lines of the mercury spectrum are accompanied in the scattered radiation by subsidiary frequencies which are found, on examination, to be due to vibrations of parts within the molecule. These are also shown by the heat radiated by the substance. The 1930 Nobel prize winner in physics, SIR CHANDRASEKHARA VENKATA RAMAN, of the University of Calcutta, discovered the effect that bears his name.*

The benzene model vibrated in several ways. The two halves sometimes vibrated like a bird flapping its wings, or three atoms went up while the alternate three went down, or all six atoms went in and out from the center. Models of toluene, carbon tetrachloride, chloroform, ethane, ethylene, acetylene, ethyl and methyl alcohol were also made and found to give good agreement with their Raman radiations. By watching the motion of the parts of these models, the chemist gets a real moving picture of the way the atoms are behaving in a chemical compound and this enables him to understand many obscure points of chemical behavior.—*Science Service*

* J. CHEM. EDUC., **8**, 183–4 (Jan., 1931).

UTAH RESEARCH FELLOWSHIPS IN MINING AND METALLURGY

The Department of Mining and Metallurgical Research of the Utah Engineering Experiment Station is maintained in cooperation with the Intermountain Experiment Station of the United States Bureau of Mines. Five fellowships will be offered by this department for the year 1931-32 and are open to college

graduates who have had the proper training in mining, metallurgy, or chemistry, and who are qualified to undertake research work. The income of each fellowship is $720, beginning July 6th and ending June 4th. Fellows are exempt from all university fees, except the general student body fee, the payment of which is optional.

Fellows will register as students in the Department of Mining and Metallurgical Research of the University of Utah and become candidates for the degree of Master of Science unless this or an equivalent degree has been earned. Their class work in the University will be directed by the heads of the departments of instruction, but the greater portion of their time will be spent in research work on the problem assigned to them, under the direction of a member of the staff of the Intermountain Station of the Bureau of Mines or the Department of Mining and Metallurgical Research.

The purpose of this work is to undertake the solution of definite problems confronting the mining and metallurgical industries. For 1931-32, fellowships will be granted in the following subjects:

1. Mining Investigations.
   (*a*) Ventilation; (*b*) Subsidence.
2. Microscopic Investigations. Statistical mineralogical studies of ores, mill products, and intermediate substances. X-ray study of crystal structure to supplement microscopic investigations.
3. Crushing and Grinding.
   (*a*) Crushing resistance of minerals; (*b*) Sizing of minerals by elutriation.
4. Flotation Fundamentals.
   (*a*) Physical-chemical investigations of flotation phenomena; (*b*) Experimental work with pure minerals.
5. Pyrometallurgy. Roasting and volatilization in connection with complex lead, zinc, and manganese ores.
6. Hydrometallurgy. Leaching of lead-zinc ores and metallurgical by-products.

Applications, with a certified copy of collegiate record, statement of experience, and names and addresses of three references, will be received up to April 15, 1931. Further information in regard to these fellowships will be furnished to those desiring the same. Applications should be addressed to the Director, Utah Engineering Experiment Station, University of Utah, Salt Lake City, Utah.

RESEARCH FELLOWSHIPS AND SCHOLARSHIPS OPEN AT INSTITUTE OF PAPER CHEMISTRY

The Institute of Paper Chemistry, Appleton, Wisconsin, has announced that it will have available for the scholastic year 1931-32 four research fellowships of $500 each, with exemption from tuition fees. In addition, there will be six scholarships which provide for exemption from tuition ($200). Inquiries regarding these fellowships and scholarships may be addressed to PROFESSOR H. F. LEWIS, Institute of Paper Chemistry, Appleton, Wisconsin.

NEW SOIL EROSION LABORATORIES PLANNED

Two new soil erosion experiment stations will be established this year by the Bureau of Chemistry and Soils, according to plans of the U. S. Department of Agriculture.

One of the new stations will be located in Georgia, the other somewhere in the Middle West. This will bring the number of soil erosion stations now established in the United States to ten.—*Science Service*

NEW RESEARCH PROJECT ON COPPER AT BATTELLE MEMORIAL INSTITUTE

The trustees of Battelle Memorial Institute, Columbus, Ohio, announce the establishment at the institute of a research project sponsored by the Calumet & Hecla Consolidated Copper Company of Calumet, Michigan. The purpose of this project is to make a fundamental study of

arsenical and argentiferous lake copper in respect to its properties and application to industrial uses.

It has long been recognized that copper containing small amounts of arsenic and silver has definite well-defined advantages and recent developments have forcibly brought to mind the possibilities of further industrial applications. This research program is comprehensive in character and is in a most promising and fertile field.

G. L. CRAIG has been added to the institute staff for work on this project, which is under the direct supervision of DR. H. W. RUSSELL and J. L. GREGG. Mr. Craig was formerly research fellow with the U. S. Bureau of Mines and more recently metallurgist for the Fairmount Aluminum Company.

THIRD INTERNATIONAL CONGRESS ON BITUMINOUS COAL

A group of prominent American men of affairs will assist in the organization of the Third International Conference on Bituminous Coal to be held November 16–21, 1931, at the Carnegie Institute of Technology in Pittsburgh, according to an announcement from that institution. Invitations were issued to a group of business men by DR. THOMAS S. BAKER, president of the Carnegie Institute of Technology and organizer of the meeting, asking them to serve in an advisory capacity to the conference. The following men accepted his invitation to serve as members of an advisory board to this third meeting on coal:

JAMES A. FARRELL, president of the United States Steel Corp.; JOHN HAYS HAMMOND, prominent mining engineer; SAMUEL INSULL, public utilities magnate; DR. FRANK B. JEWETT, president of the Bell Telephone Laboratories, Inc.; HON. A. W. MELLON, secretary of the U. S. Treasury and capitalist; F. A. MERRICK, president of the Westinghouse Electric and Manufacturing Co.; AUGUSTE G. PRATT, president of the Babcock and Wilcox Co.; H. B. RUST, president of the Koppers Co.; MATTHEW S. SLOAN, president of the New York Edison Co.; GERARD SWOPE, president of the General Electric Co.; and WALTER C. TEAGLE, president of the Standard Oil Co. of New Jersey.

This group of men are connected with industries either directly or indirectly concerned with coal and its by-products. Seven members of the board for the third meeting served in a similar capacity at the second meeting in 1928.

Word comes from Dr. Baker, who is now in Europe inviting scientists to the third meeting, that the idea of a third conference is being warmly received by fuel technologists abroad and that the continent will be well represented as it has been in the past sessions.

The meetings are organized for the purpose of finding new uses for soft coal. By bringing together the best minds in the field of fuel technology an interchange of ideas and new methods is secured which keeps the coal industry informed of new processes which are being used throughout the world. The proceedings of the congresses are published, and are now considered standard reference books on fuel technology.

The program this year, according to a preliminary announcement, will include papers on the carbonization, liquefaction, and gasification of coal; by-products; the mechanism of combustion; cleaning of coal and its preparation for the market; pulverized fuel; power plants; and domestic heating. Emphasis will be placed on the economics of the new processes discussed.

DR. WIELAND GIVES SILLIMAN LECTURES AT YALE

According to *Science*, Yale University announces the appointment of DR. HEINRICH WIELAND, professor of organic chemistry at the University of Munich and one of the editors of the *Annalen der Chemie*, as Silliman lecturer for the current year. The subject of the lectures is "Researches on Oxidation Reaction." They are scheduled for 4.15 P.M. in the lecture room of the Sterling Chemistry

Laboratory on March 16th, 18th, 20th, 23rd, 25th, and 26th. As provided for by the Silliman Foundation, these lectures in amplified form will be published by the *Yale University Press* as a volume of the Silliman series.

PROFESSOR FOWLER TO LECTURE AT UNIVERSITY OF WISCONSIN

PROFESSOR R. H. FOWLER, of Trinity College, Cambridge, will give a series of twenty-four lectures at the University of Wisconsin, on "Some Recent Developments in Theoretical Physics." The topics to be covered include electron emission, the theory of ferro-magnetism, the internal absorption coefficient for gamma rays and Milne's theory of the internal constitution of the stars. The lectures will begin on April 1st and will continue through April and May. Visitors are invited to attend the lectures.—*Science*

INDUSTRIAL CHEMISTS MAKE CONTACT WITH UNIVERSITY RESEARCH THROUGH LECTURES AT UNIVERSITY OF CHICAGO

Members of the faculty of the University of Chicago are presenting a series of lectures for the research staff of Swift & Company during the winter quarter. The following lectures form the schedule:

February 2—"The Ring Structure in Sugars," J. W. GLATTFELD.

February 9—"Liquid Ammonia as a Solvent," WARREN C. JOHNSON.

February 16—"Recent Studies in Molecular Structure by Means of X-Rays," W. C. PIERCE.

February 25—"Auto-Oxidation," H. I. SCHLESINGER.

March 2—"Recent Advances in Inorganic Chemistry," WARREN C. JOHNSON.

March 9—"Ortho and Para-Hydrogen," T. R. HOGNESS.

March 16—"The Modern Analytical Technic for Small Quantities," MORRIS S. KHARASCH.

March 23—"The Physico-Chemical Significance of the Einstein Theory," ARTHUR C. LUNN.

March 30—"The Chemistry of Proteins," F. C. KOCH.

April 6—"The Factors Determining the Nutritive Value of Proteins," F. C. KOCH.

A similar series of lectures was given during the autumn quarter by members of the physics and chemistry departments. These lectures are concerned with the special fields of interest of the individual speakers. The plan is to bring the industrial research men in contact with the numerous fields of endeavor under investigation in the university laboratories. DR. W. D. RICHARDSON, chief chemist of Swift & Company, has inaugurated here a plan that is unique in character and purpose, and promises to act as a stimulus for similar projects. These series of lectures have been planned through the University College of the University of Chicago.

DR. RIGGS ADDRESSES NEW YORK PROFESSIONAL GROUP OF ALPHA CHI SIGMA

At the February 4th meeting of the New York Professional Group of Alpha Chi Sigma, held at the Prince George Hotel in New York City and attended by thirty-three members of the fraternity representing all parts of the country, an address on "Historical Aspects of Nutritional Observations and Studies" was given by DR. LLOYD K. RIGGS, director of research, New Jersey College of Pharmacy, Newark, N. J. Dr. Riggs spoke of various observations on foods made by DAVID LIVINGSTONE in his African explorations. He described the logs obtained from various early New England sailing vessels as yielding some very interesting observations on nutritional ailments. Both these accounts gave data on the prevalence and early knowledge of scurvy. Dr. Riggs also mentioned that it was a common practice to force the crews of certain vessels to eat grass on first reaching land.

The speaker referred to the attempts of the Japanese to build the finest navy in the world, of the appearance of beriberi and the revelations of the logs of the battleships and the Japanese naval hospital.

He also discussed the nutritional work of MAYO, LAVOISIER, RUBNER, BENEDICT, and others, emphasizing the astonishing accuracy of the earliest work and the increased refinements and accuracy of the later studies which led researchers in the field to conclude at the end of the last century that all nutritional work had been completed and that the only other advances which could be made would be in the line of methods.

DR. HAAS LECTURES AT PENNSYLVANIA STATE COLLEGE

Under the auspices of the School of Chemistry and Physics, and the Sigma Pi Sigma and Phi Lambda Upsilon fraternities, DR. ARTHUR HAAS, professor of physics at the University of Vienna, gave two lectures recently at the Pennsylvania State College, one on "Modern Physics and Our Views on the Universe," the other on "Light Corpuscles, Material Waves, and the Laws of Physics."

ELEVENTH OHIO STATE EDUCATIONAL CONFERENCE

The Eleventh Ohio State Educational Conference will convene at The Ohio State University, Columbus, Ohio, on April 9th, 10th, and 11th. The following program for the Physical Science Section has been arranged:

Friday, April 10

2:30 P.M. Chemistry Building, Room 100. Presiding, ALPHEUS W. SMITH, The Ohio State University.

1. "Solar Radiation," CHARLES G. ABBOTT, secretary of Smithsonian Institution.
2. "Chemistry in the Quest for Health," OLIVER KAMM, Parke, Davis and Co., Detroit, Michigan.

6:00 P.M. Executive Committee Dinner and Meeting, Ohio Chemistry Teachers Association.

7:30 P.M. Physical Science Section Entertainment and Social Hour. Chemistry Building, Room 100.

Saturday, April 11

8:45 A.M. Registration. The registration card will contain a blank space for helpful suggestions relative to topics and speakers for the Saturday forenoon program of next year. There is no fee for this special Physical Science Registration.

9:00 A.M. Chemistry and Physics Symposium, Mendenhall Laboratory of Physics, Room 200. Presiding, J. E. DAY, The Ohio State University.

"What May the College Teacher in the Physical Sciences Expect from the High-School Graduate?"

R. L. EDWARDS, Department of Physics, Miami University, Oxford.

ROY I. GRADY, Department of Chemistry, Wooster College, Wooster.

WALTER FRYE, Department of Physics, Central High School, Akron.

VERNON S. CULP, Department of Chemistry, West High School, Akron.

Discussion.

10:30 A.M. *Divisional Meetings*

A. Division of Chemistry, Mendenhall Laboratory of Physics, Room 212. Presiding, ERWIN R. SHADE, Harding High School, Marion.

"The New-Type (Objective) Examination in High-School Chemistry," K. M. PERSING, Glenville High School, Cleveland.

Discussion.

Business Session.

B. Division of Physics, Mendenhall Laboratory of Physics, Room 210. Presiding, CHARLES W. JARVIS, Ohio Wesleyan University, Delaware.

"A Cross-Section of Physics in the Various Types of High Schools,"

O. C. MONTGOMERY, West High School, Columbus.
B. F. SALISBURY, Lincoln High School, Cleveland.
THOMAS GRAHAM, Delaware High School, Delaware.
H. R. FISHER, Sunbury High School, Sunbury.

Business Session.

12:30 P.M. Special Luncheon—Physical Science Section, Pomerene Hall. Price, $0.60.

The Physical Science Section will hold open house to its guests in the chemistry and physics laboratories on Friday afternoon and evening and Saturday forenoon. There will be an opportunity to see something of the teaching and research in progress in these laboratories. For the benefit of teachers of chemistry and physics in colleges and secondary schools, the Central Scientific Company and the Welch Mfg. Co., each, will have an exhibit of scientific apparatus in the chemistry building on Friday afternoon and Saturday. These exhibits will also interest superintendents and principals responsible for the purchase of apparatus for their chemical and physical laboratories.

Hotel Accommodations

Those desiring hotel accommodations may obtain them by direct communication with any of the following hotels: Neil House, Deshler-Wallick Hotel, Chittenden Hotel, Fort Hayes Hotel, the Hotel Francis, at the customary rates of $3.00 up for a single room without bath, and $5.00 up for a double room without bath. The Hotel Willard is a small hostelry near the campus and accommodates transients at the rate of $1.00 per night per person. A number of rooming houses in the University vicinity also offer rooms at $1.00 per person.

Those desiring accommodations may communicate directly with the hotel desired or else with JESSE E. DAY, Department of Chemistry, The Ohio State University, Columbus, Ohio.

THE KANSAS ASSOCIATION OF CHEMISTRY, PHYSICS, AND GENERAL SCIENCE TEACHERS

At the annual meeting of the Kansas Association of Chemistry, Physics, and General Science Teachers, on January 24th, the following papers were presented:

"The Teaching of General Science," JESSE WESTERDALE, Wakefield, Kansas; "The Physics Teacher as a Technician," LEO HUDIBURG, Kansas State Agricultural College, Manhattan; "What the College Chemistry Teacher Should Expect of High-School Chemistry Students," L. C. HECKERT, Kansas State Teachers' College, Pittsburg; "Science Teaching in the High Schools," J. E. EDGERTON, State High School Inspector, Topeka; "Self-Grading Tests in Chemistry and Other Sciences," J. A. BROWNLEE, Wichita High School East, Wichita.

THE CHEMISTRY TEACHERS CLUB OF NEW YORK

This organization held its 203rd meeting on February 4, 1931. The program follows:

"Brief Discussion of Some of the Problems of Chemistry Teaching in Secondary Schools," PROFESSOR A. HURD, Teachers' College, Columbia University.

"Use of Biographical Material in Teaching Chemistry," MR. J. C. PRINZ, DeWitt Clinton High School.

"Chemical Equations and Their Development," MR. MAURICE U. AMES, Flushing High School.

"The Superior Pupil," MR. SAMUEL B. YACKNOWITZ, Walton High School.

"Chemistry Work Book," MISS RUTH JOHNSON, Newtown High School.

"Preparation of Crystals; Nitration with Metallic Nitrates," MR. LEONARD J. FLIEDNER, George Washington High School.

Discussion from the floor.

The paper by Mr. Yacknowitz was supplemented by exhibits of student work. These exhibits are suitable for display to the public and were successfully used to stimulate interest in chemistry.

The specimens shown by Mr. Fliedner elicited much favorable comment. He had succeeded in preparing large crystals of chrome alum, the largest weighing over 2.3 kilos. He also demonstrated the new method of nitration by preparing a quantity of 5-nitro salol; the nitrating reagent consisted of a mixture of cupric nitrate, glacial acetic acid, and acetic anhydride.

NEW SCIENCE BUILDING FOR THE PHILLIPS EXETER ACADEMY

A new science building, the gift of the late COLONEL WILLIAM BOYCE THOMPSON, of the class of 1891, is being erected for the Phillips Exeter Academy. The new structure will be twice the size of the two buildings now used by the science departments of the institution. The first floor will be used for physics, and the second and third for chemistry. The size and arrangement of rooms will be consistent with the new methods of small-group instruction to be incorporated throughout the academy as a result of the recent Harkness gift. It is hoped that the building will be ready in time for the 150th anniversary of the founding of the academy in June, 1931, and that the installation of equipment will permit the use of the building at the opening of the fall term of 1931.

VOCATIONAL LECTURES FOR HIGH-SCHOOL STUDENTS AT SYRACUSE UNIVERSITY

The Department of Chemistry at Syracuse University conducted a series of four lectures on chemistry topics at Bowne Hall on February 19th and 20th. The lectures were given to selected high-school students of Central New York.

The topics selected were Organic Chemistry, Chemistry in Medicine, X-Rays, and Chemical Industries of Syracuse. The speakers for the occasion were members of the department of chemistry at Syracuse University: PROFESSOR C. C. SPENCER, PROFESSOR R. K. BREWER, PROFESSOR A. J. KING, and PROFESSOR ALBERT SALATHE.

The program was in charge of PROFESSOR A. L. ELDER of the Syracuse chemistry department.

DEUTSCHE BUNSEN GESELLSCHAFT

The thirty-sixth general meeting of the Deutsche Bunsen Gesellschaft für angewandte physikalische Chemie, an association of leading research workers, scientists and technologists in the field of applied physical chemistry will take place from the 25th to the 27th of May, 1931, in Vienna. The subject of the symposium will be: "Recent Progress in the Science of Metallurgy with Particular Reference to Light Metals." The arrangements have been undertaken by GEHEIMRAT PROF. DR. ING. H. C. SPECKETER, director of the I. G. Farbenindustrie A.-G., managing director of the Griesheim Elektron Works.

The following papers will be presented: "Recrystallization," PROFESSOR DR.-ING. H. C. G. TAMMAN, of Göttingen; "Electric and Magnetic Properties of Metals," PROFESSOR DR. R. BECKER, of Berlin-Wannsee; "Metallurgical Problems Connected with Aluminum and Its Alloys," DR.-ING. G. SACHS, of Frankfurt am Main; "Compensation and Precipitation Hardening of Alloys," DR. G. MASING, Berlin-Siemensstadt; "A Contribution to the Physics and the Metallography of Magnesium," DR. E. SCHMID, Berlin-Dahlem.

FLORIDA SECTION, A. C. S., SPONSORS RADIO TALKS

Radio talks sponsored by the Florida Section have been given from State Radio Station WRUF in Gainesville, 361.2 meters and 830 K.C., on Fridays at 6.00 P.M., Eastern Standard Time. The programs included the following:

Feb. 13, "The Necessity of Growing Timber in Florida, and the Possibility of Pulp and Paper Making as a Result," P. N. HOWELL, chief forester of Southern Kraft Paper Corporation; Feb. 20, "The Production of Book and Other White Paper from Southern Pine." W. L. WIL-

SON, Panama City; Feb. 27, "Research in Forest Management," S. J. HALL, Jacksonville; March 6, "Chemical Utilization of Citrus Fruit Products," W. W. SKINNER, Department of Soils and Chemistry, U. S. Department of Agriculture; March 13, "Minerals of Florida" by JACK FROST, Florida Portland Cement Co.

NORTHEASTERN SECTION, A. C. S., CHEMISTRY BROADCASTS

Through the courtesy of MR. JOHN SHEPARD, 3RD, president of the Shepard Broadcasting Service, the Northeastern Section of the A. C. S. is presenting a series of BROADCASTS IN CHEMISTRY every Thursday afternoon from 4.15 to 4.30 over the following stations of the "Yankee Network:" WNAC, Boston, 1230 kilocycles; WEAN, Providence, 780 kilocycles; WICC, Bridgeport, 1190 kilocyles. Later the program will go out over WORC, Worcester, 1200 kilocycles.

The first program was presented on February 19, 1931. All the radio addresses will be published as supplements to the *Nucleus*.

The subjects of each broadcast will appear in the radio sections of the daily press.

DR. LUCKHARDT ADDRESSES JOURNAL SOCIETY OF DE PAUL UNIVERSITY

On Sunday, January 25th, at the Morrison Hotel, Chicago, DR. ARNO B. LUCKHARDT, professor of physiology at the University of Chicago, delivered an illustrated lecture before the members of the Chemistry and Physics Journal Society of De Paul University, on "the Discovery and Uses of Ethylene Oxide as an Anesthesia."

Dr. Luckhardt narrated many interesting personal anecdotes associated with the discovery of this important anesthetic. As has frequently happened in science, the discovery proved to be an ulterior objective in an otherwise rather unimportant research problem.

The acumen of the learned investigator was apparent. Immediately he perceived the importance of these early experiments and promptly applied them to a practical advantage. Frogs and dogs proved the faithful laboratory animals for the subsequent investigations. Ethylene oxide shortly afterwards took its place among the ranks of general anesthetics.

In conclusion, Dr. Luckhardt made an appeal to the student body, informing them of the necessity of instructing misguided persons relative to the anti-vivisection propaganda. He intimated that if it were not for the legal experimentation upon the lower forms of life the discovery of ethylene as an anesthetic would never have been possible. No animal is ever inhumanely treated during the course of an investigation.

THE E. H. S. BAILEY PRIZE IN ANALYTICAL CHEMISTRY AT UNIVERSITY OF KANSAS

The chemistry department of the University of Kansas has recently awarded the E. H. S. Bailey prize for excellence in analytical chemistry to WREN GABEL, a senior in the school of engineering. DR. E. H. S. BAILEY, professor of chemistry at this university since 1883, is a firm believer in the importance of qualitative and quantitative analysis as a foundation for all chemical work. He therefore offered to nominate for full membership in the American Chemical Society the student having the best record in both branches of analytical chemistry and to pay the first year's dues. Dr. Bailey has announced that he will offer this prize again next year.

DR. KAEMPFFERT RESIGNS DIRECTORATE OF MUSEUM OF SCIENCE AND INDUSTRY

DR. WALDEMAR KAEMPFFERT, after having spent two and a half years in organizing the Museum of Science and Industry at Chicago, has handed in his resignation as director, effective on March 1st. Mr. Kaempffert will become a member of the

editorial council of the *New York Times* and will direct that paper's policy so far as science, engineering and industry are concerned. The work of designing and collecting exhibits for the museum will go forward uninterruptedly in accordance with the program originally formulated by Mr. Kaempffert and approved by the board of trustees.—*Science*

NATIONAL INDUSTRIAL MUSEUM DISCUSSED BY CONGRESS

The first legislative hurdle has been successfully cleared by the Copeland bill to establish a commission to study the need of a new engineering and industrial museum at the Smithsonian Institution. The bill passed the Senate at one of the recent night sessions during which bills on the calendar came up for consideration.

If the bill also gets through the House, nine men, including an engineer, an industrial chemist, a manufacturer, three men experienced in transportation by land, air, and water, respectively, an educator, a labor representative, and a museum expert will serve without pay to see what is best to be done about exhibits of this character in the museum which will have no home when the present arts and industries building of the U. S. National Museum is razed to make way for widening of a street in that vicinity. Recommendations for the new building will be presented at Congress and the President as soon as feasible.—*Science Service*

THIRTEENTH EXPOSITION OF CHEMICAL INDUSTRIES

The Thirteenth Exposition of Chemical Industries will be held at the Grand Central Palace in New York from May 4 to 9, 1931. Every second year this exposition draws several hundred exhibits not only from the forty-odd chemical industries, but also from a large number of others which supply raw materials or plant or laboratory equipment used in chemical processes.

One of the interesting and important lines of developments in modern chemistry has been the steady improvement in molding plastics and other synthetic resins, and the exhibits of these products always attract lively interest. As heretofore, the coming exposition will have exhibits of these products; and while they overlap in some competitive fields, a few of them have branched out along new trails where competitors have not followed.

A development of the past two years has been the introduction by one manufacturer of six new pastel colors, all of which will be included in the exhibit of their producer. Pastels, even at such a late date as the last chemical exposition, were not shown by manufacturers of phenolic compounds. In fact, the very possibility of their existence or production was doubtful. Since then, six new colors have been produced, and are now on the market. They are pink, blue, green, yellow, old ivory, and gray.

In addition to their novelty and beauty, it is reported that these materials are capable of being molded under conditions similar to molding conditions of standard compounds, using the same equipment and steam pressure, while their water absorption is said to be less than that of the older phenolic compounds. At the same time, they are as strong as the standard materials; and are now in production on several parts requiring large quantities of compound. In the same booth will also be shown many new molded pieces larger than heretofore exhibited, for a variety of industrial uses. These include soda fountain chairs, iceless refrigerator parts, and a wide variety of other industrial applications.

As a rule, plastics have not been much used in packaging, but one manufacturer has gone extensively into that field, and his comprehensive line of packaging equipment, from seals for collapsible tubes, bottles and jars to display racks, containers and electric signs, will be on exhibition. Other features of his exhibit will be the new core resin, finding wide acceptance in foundries for the manu-

facture of cores of complicated design; and several applications of phenolic varnishes.

Another curious and interesting development of recent years has been the immense increase in the efficiency of the so-called "activated carbons" over similar adsorption agents of past years. Wood charcoal had been used for removal of undesirable odors and colors for many years, and during the war "gas-mask" carbon, having a far greater efficiency, was developed. Bone char is a key material in the refining of sugar, but for decolorants, modern activated carbons are from twenty to fifty times as effective as bone char. Some of the latest of these activated carbons were shown at the last chemical exposition; but research is constantly developing new and interesting uses for them, two of the latest being in water purification and iodine adsorption.

Activated carbons remove unwanted colors, odors, and flavors from liquids and gases by adsorbing them; that is to say, by condensing them and packing them away, in a fraction of the space they formerly occupied, in the myriad microscopic or sub-microscopic pores of the adsorbing material. So porous is good activated carbon, that it is estimated that a cubic inch of the material will have a surface area of 20,000 square yards. Incomprehensible as that may seem, any skeptic can convince himself of the possibility of the fact by a simple mathematical calculation, bearing in mind that the pores which perform the operation of adsorption are probably of molecular size.

The operation of activated carbon in the removal of impurities depends upon an affinity of those impurities for the snug retreats of the carbon; or to put the same thing differently, it depends upon the ability of the carbon to take the undesirable materials away from the material to be purified, and pack them down tight in its infinitesimal cavities. Naturally, the capacity of activated carbon for any impurity is strictly limited; and when it has become saturated, it must be withdrawn from the operation and either discarded or re-activated, so that it may be used again.

From the foregoing, it is evident that activated carbon will produce the desired results only when the carbon has a stronger affinity for the undesirable ingredients than the substance to be purified; but as this is the case in a very great range of chemicals, activated carbon has a large field of usefulness. A number of these uses will be illustrated in the coming Exposition of Chemical Industries.

NORTH LOUISIANA CHEMICAL SOCIETY

The North Louisiana Chemical Society held its annual banquet for its members, their wives and guests at the Washington-Youree Hotel in Shreveport on January 27th. Forty persons were present. The address of the evening was given by the incoming president, DR. JOHN B. ENTRIKIN, head of the Department of Chemistry of Centenary College, Shreveport, who spoke on "The Need for a Chemical Industrial Survey of This Area." Other officers for the coming year are: *vice president*, C. W. JONES, president of the Jones Chemical Company; *secretary*, PAUL SLOAN, Louisiana Oil Refining Company; *treasurer*, JOHN RAILSBECK, Louisiana Oil Refining Company. The society meets once each month at Centenary College.

NEW APPOINTMENTS BY AMERICAN CERAMIC SOCIETY

DR. ALEXANDER SILVERMAN, head of the department of chemistry, University of Pittsburgh, was made vice president of the American Ceramic Society at a meeting held in the ballroom of the Cleveland Public Auditorium on February 25th. He, together with DR. E. W. TILLOTSON and MR. S. M. PHELPS of the Mellon Institute of Industrial Research, were included in the first list of fellows appointed by the society at this meeting.

STAFF CHANGES AT MELLON INSTITUTE

DR. EDWARD R. WEIDLEIN, director of the Mellon Institute of Industrial Research at Pittsburgh, has announced the appointment of DR. LEONARD HARRISON CRETCHER to an assistant directorship in the institution. Dr. Cretcher, who since 1926 has been serving as head of the department of research in pure chemistry, is a specialist in organic chemistry and will have supervisory charge of a group of industrial fellowships that are concerned with problems in organo-chemical technology. In addition to serving in this capacity, Dr. Cretcher will continue as head of the department of research in pure chemistry. In this work he will be aided by DR. WILLIAM L. NELSON, who has been made senior fellow in pure research. Beside Drs. Cretcher and Nelson, the departmental staff will include DR. C. L. BUTLER and DR. ALICE G. RENFREW, who has gone to the Mellon Institute from the Sterling Chemistry Laboratory of Yale University.—*Science*

FACULTY APPOINTMENTS AT COOPER UNION

PROFESSOR ALBERT B. NEWMAN, head of the Department of Chemical Engineering, has recently been appointed to the Membership Committee of the American Institute of Chemical Engineers.

PROFESSOR HENRY C. ENDERS has been appointed to membership on the Committee of Law and Ethics, and also elected to the Committee on Nominations of the New York State Society of Professional Engineers, New York Chapter.

MR. CHRISTIAN WEAVER, Instructor in Organic Chemistry, was elected to the presidency of the Cooper Union Chemical Society at its recent meeting. Mr. Weaver has been teaching in Cooper Union for twenty-five years, and will use his wide experience to effect a complete reorganization of the society upon a more modern basis.

EDGAR FAHS SMITH MEMORIAL COLLECTION AT UNIVERSITY OF PENNSYLVANIA

The Edgar Fahs Smith Memorial Collection in the History of Chemistry, which was presented to the University of Pennsylvania two years ago, has been endowed by MRS. EDGAR F. SMITH. The collection is located in the Harrison Laboratory of Chemistry, and comprises rare books in chemistry, portrait prints and engravings, manuscripts and autograph letters. A catalog is in course of preparation and will shortly be available for distribution. MISS EVA V. ARMSTRONG, who was formerly Dr. Smith's secretary, has been appointed curator.

Bucky Boundary Ray Now Used against Forgers. Life for forgers and counterfeiters promises to be harder in the future. To ultra-violet radiation and Röntgen rays, now used in probing beneath the surface of etchings, postage stamps, and documents for photographic evidence of falsification, has been added the Bucky Boundary Ray.

This radiation, lying in the spectrum between the ultra-violet and X-rays, has been found superior for penetrative lighting purposes in cases where ultra-violet rays have too small and Röntgen rays too strong a penetration, reports to the American Chemical Society from Germany indicate. Like the X-rays and the ultra-violet light, the boundary rays consist of waves too short to affect the eye, they are longer than the X-rays but not as long as the ultra-violet. They must be used in a vacuum as they are strongly absorbed by air.

Prof. B. Spiethoff, O. Gfrorer, and Heinz Berger, who developed the new detective method at the University Dermal Clinic at Jena, have called upon professional men to test out these unfamiliar rays and report on their efficiency in various types of investigation.—*Science Service*

Recent Books

Treatise on Physical Chemistry. HUGH S. TAYLOR, D.Sc., *editor*, David B. Jones Professor of Chemistry, Princeton University, Princeton, N. J. Second edition, D. Van Nostrand Company, Inc., New York City, 1931. 2 Volumes. Vol. 1, xv + 852 + 48 pp.; Vol. 2, xii + 1766 + 48 pp. 15 × 22.5 cm. Volumes not sold separately. $15.00.

The second edition of this well-known work has been enlarged over thirty-five per cent. This gives some idea of the increase in knowledge of the subject treated therein during the last five years. It also furnishes some conception of the task confronting the contributors to this coöperative effort.

The first notable change is to be found in Chapters III and IV on "The Kinetic Theory of Gases and Liquids" and "Imperfect Gases and the Liquid State." Written by Drs. Herzfeld and Smallwood, they require together no less than 177 pages representing an increase of 100 pages. Those wishing a detailed discussion of the kinetic theory will find it here. The chapter on "Thermochemistry" has been enlarged about thirty-five per cent. Chapter XII, "The Electrochemistry of Solutions," has been moved forward to Volume I.

Considerable new material has been incorporated in the chapter on electrometric methods. Dr. Urey has collaborated with Dr. Rice in writing Chapter XIV. The Chapter on "Reaction Velocity in Heterogeneous Systems" has been expanded. Dr. Dushman's Chapter on "Quantum Theory and Atomic Structure" has been enlarged to 278 pages. It formerly required 126 pages. Of special interest in the way of new material is his discussion of the newer work on the nature of the electron, etc. In spite of this great enlargement, it has been found necessary to omit any discussion of the Lewis-Langmuir atom model. In fact it is not discussed anywhere in the two volumes. This is unfortunate as there is still much to be learned from it.

Dr. Webb has collaborated with Dr. Rodebush in writing Chapter XVII. Dr. Taylor has enlarged his chapter on "Photochemistry" by twenty-five per cent. The Chapter on "Infra-Red Radiation in Chemical Processes" has been doubled in size. In this second edition the chapter on "Colloids" has been written by Dr. E. O. Kraemer. It has been expanded from 44 to 156 pages. The quantitative aspects are considered more fully and the recent developments thoroughly discussed. The chapters not mentioned have been in nearly every case carefully revised and somewhat enlarged.

As in the previous edition, the binding and printing are excellent. The indices are easy to use and very full. The illustrations are numerous and there are three excellent halftone photographic reproductions. The references are exceedingly abundant. For one man to criticize adversely such a work would verge on the presumptuous. Suffice it to say that no teacher of chemistry, research chemist or advanced student can afford not to have this "Treatise" at his elbow.

MALCOLM M. HARING

UNIVERSITY OF MARYLAND
COLLEGE PARK, MD.

Colloid Symposium Monograph. Papers presented at the Eighth Symposium on Colloid Chemistry, Cornell University, June, 1930. Edited by HARRY BOYER WEISER, Professor of Chemistry, The Rice Institute. *The Journal of Physical Chemistry*, 654 Madison Avenue, New York, N. Y., 1931. 422 pp. 169 figs. 17 × 26.5 cm. $2.00; without author and subject indexes, $1.50.

This volume serves to collect under one cover the twenty-eight papers read

at the Eighth Colloid Symposium. The exceedingly wide scope of the studies made in the field of colloid chemistry is reflected in the diversity of topics touched upon by the papers in this Monograph. One finds studies of such fundamental problems as coagulation, stabilization, adsorption, optical properties, determination of particle size, ultra filtration, swelling, electrical phenomena, and other papers dealing with applications of colloid chemistry to numerous fields, among which are photography, anesthesia, behavior of clays and of paints, and the removal of carbon monoxide from automobile exhaust gases.

That scientific knowledge is accumulating at a tremendous rate is apparent to every student of any branch of science. The publication of the increasingly large amount of work being done in colloid chemistry performs a valuable function in the training of chemists. On the one hand, the multiplicity of subjects covered will arouse in the student a keen appreciation of the magnitude of the field of chemical knowledge, yet, on the other hand, the emphasis which is made in studies of colloids on phenomena occurring at interfaces will offer him a basis for correlating and rationalizing the multitude of facts with which he must deal. The series of Colloid Symposium Monographs constitutes a valuable part of the literature of colloids and this latest volume will find its place on library shelves to aid the student in his task. Its value as a reference is marred to some extent by the occurrence of five erroneous page references in the table of contents and at least some of these errors are repeated in both the author and subject indexes. Nevertheless, taken as a whole, this volume is a contribution of great value.

S. ALLAN LOUGH

UNIVERSITY OF NEVADA
RENO, NEVADA

Mikrochemisches Praktikum. F. EMICH, Professor at the Technische Hochschule, Graz. Second edition. With a section on Tüpfelanalyse, by DR. FRITZ FEIGL, Privatdozent, University of Vienna. J. F. Bergmann, München, Germany, 1931. xii + 157 pp. 83 figs. 15 × 23.5 cm. Rm. 12.80.

In the first few lines of the preface of the first edition of "Mikrochemisches Praktikum," Emich forecasts the more general use of microchemical methods: "I believe the time is not far off when we must demand from the majority of our younger professional colleagues a certain familiarity with these (micro) methods." Micro methods will never entirely replace macro methods, but their use is increasing rapidly, and there are times when they are absolutely indispensable.

The appearance of the second edition of Emich's "Microchemical Practice" is, therefore, very timely, as it includes a description of the absolutely necessary, as distinguished from the desirable, equipment of the microchemical laboratory, and also a discussion of the methods available for carrying out any operations likely to be encountered.

Part I of the book is devoted to apparatus and methods, and is subdivided into sections A and B, the former dealing with qualitative and the latter with quantitative methods.

Part II includes many laboratory exercises, and provides the student with laboratory directions which should give him a good knowledge of the micro reactions of the common inorganic cations and anions, and a training in the more common procedures of analytical and synthetic organic microchemistry. As the title states, the book does not cover the same field as does Pregl's "Quantitative Organic Microanalysis."

The short section by Dr. Fritz Feigl serves well to introduce a very useful method of analysis, which, for lack of a better name, might be called "drop analysis." Included are a general description of the aims and technic of the method, and a number of laboratory experiments by which the student may acquaint himself with some of the common operations.

The experiments are selected from the field of inorganic chemistry.

A student who has worked through this book in an intelligent way should be in a position to carry on microchemical work unassisted, devising for himself new methods when the need for them arises.

Print and paper are good, and references to the original literature are frequent. The book should be a worthwhile addition to the library of any one interested in microchemical methods.

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Non-Interpolating Logarithms, Cologarithms, and Antilogarithms. FREDERICK W. JOHNSON, M.A., Instructor of Chemistry, California College of Pharmacy, University of California. Fabrikoid edition, No. 2 of the Simplified Series. The Simplified Series Publishing Company, 1381 Third Avenue, San Francisco, California, 1930. x + 23 pp. (tables, occupying 96 pp., not numbered). 15.75 × 21 cm. $2.25.

The book contains an introduction to the theory of logarithms with illustrations of their use in calculations; illustrations of the use of the non-interpolating tables; tables, and explanation of formulas, for the calculation of the logarithmic trigonometric functions of small (or large) angles; tables of constants with their logarithms and cologarithms; and the following non-interpolating tables:

A five-place table of logarithms and one of antilogarithms for all numbers of five significant figures.

A five-place table of cologarithms for numbers of three significant figures.

Four-place tables of logarithms, of cologarithms, and of antilogarithms for numbers of four significant figures.

The unique feature of the new tables is the printing arrangement which enables the author to give, directly in the tables, logarithms which in ordinary tables are obtained with the aid of interpolation. The number of pages required is not excessive—just double that required for the common interpolating tables. Each logarithm, being read directly from the tables, has a value which is the properly rounded-off value of the corresponding logarithms in six- or seven-place tables. Thus there is, in these tables, no discrepancy between the logarithm of a number obtained from the four-place table or the five-place table. The tables have been adequately proof-read, or will be soon, since the publishers announce: "For each individual figure in the following tables that is found to be numerically incorrect, a complimentary leather-bound copy of this book will be sent to the person who first reports such an error."

Two considerations will weigh with the teacher who recommends tables of logarithms for his classes—speed in the use of the tables and accuracy in the final result. The student will make greater speed getting the logarithm by inspection of a table than by interpolation. It happens, however, that in most calculations where five-place accuracy is desired in the product, some of the factors have four figures or less. The logarithms of such factors are read directly from the common logarithm tables, and are read more quickly than from the non-interpolating tables. One may therefore predict that, due to the two opposing effects on the speed of calculation, there will be no great difference favoring either the interpolating or non-interpolating tables.

The accuracy of the final result depends both on the accuracy of the table used and on that of the user. It is a well-known fact that an interpolation correctly done sometimes yields a result which differs from the corresponding rounded-off value from a more comprehensive table. Thus, a five-place table, for the logarithm of 273.1, gives 2.43632, an interpolating table gives 2.4364 and the non-interpolating gives 2.4363, as it should. It should be remembered, however, that the value from the non-interpolating four-place table is a rounded-off value, and that the sum of such rounded-

off values may be incorrect if the errors of rounding-off have the same sign. Hence the non-interpolating four-place table will not serve for a five-place table where five-place accuracy is needed, although it will obviate annoying differences such as that illustrated above. Too, the errors made in interpolation are avoided by the new tables, and these occur frequently enough. The very compactness of the non-interpolating tables, and they must be compact to contain so much information in so few pages, unfortunately makes the tables harder to read, increasing the chance that the right logarithm for the wrong number is secured. This possibility is outweighed by the advantages of the non-interpolating tables, and the decision on the score of accuracy must be in their favor.

Many students do not like to interpolate, and will even go to the length of using a five-place table solely to avoid the necessity of interpolation. They should find the new four-place tables a boon. If students are persuaded by the convenience of the tables to make all calculations only to the degree of accuracy indicated by their data, the tables will fill a useful purpose. The reviewer ventures to suggest, however, that all students be taught to interpolate so that they may not be dependent on a single book of tables.

The tables are well printed on good paper, and are equipped with an index. It is regrettable that the publishers did not see fit to protect their really excellent printing with a binding of better quality. The tables are well worth examination for personal use or for the use of a class. The publishers distribute gratis a reprint of their non-interpolating four-place antilogarithms (No. 4 of the Simplified Series); the opportunity for examination should be accepted by all in need of logarithm tables.

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Elements of Chemical Engineering. WALTER L. BADGER, Professor of Chemical Engineering, and WARREN L. MCCABE, Assistant Professor of Chemical Engineering, University of Michigan. Introduction by ARTHUR D. LITTLE. First edition, McGraw-Hill Book Company, Inc., New York City, 1931. xvii + 625 pp. 314 figs. 13 × 23 cm. $5.00.

In 1923, Professors Walker, Lewis, and McAdams of the Massachusetts Institute of Technology published a book called "The Principles of Chemical Engineering." Now, in 1931, Professors Badger and McCabe of the University of Michigan publish a book entitled, "Elements of Chemical Engineering." These two books represent the only textbooks in English at the present time on the fundamentals of chemical engineering. There is no question about the value and popularity of Walker, Lewis, and McAdams' famous text and in the reviewer's opinion there will be no question about the value and popularity of Badger and McCabe's new text.

The authors have stated their reason for writing this new text, recognizing that a simpler and more descriptive text might be of interest in some of our schools. Of course, much of the mathematical and so-called theoretical treatment of the subject is the same in both texts. Badger and McCabe, however, have given considerably more descriptive matter concerning equipment, the value of which is apparent.

Dr. Arthur D. Little has written the introduction. He has shown clearly and in his own interesting style the difference between industrial chemistry and chemical engineering. Industrial chemistry involves only the application of the science of chemistry, whereas chemical engineering, according to Dr. Little, is largely concerned with certain physical operations known as unit processes common to chemical manufacture.

Badger and McCabe have left out consideration of combustion and furnace design. This subject is, after all, an industrial chemical unit process and not a physical unit process. The authors have

added certain unit processes to their text such as crystallization, mixing, conveying, and weighing. These subjects were not in the older text and are a welcome addition.

Under the heading "Transportation of Fluids" is considerable practical knowledge involving pipe fittings, valves, and pumps. This information, of course, was available before, but not in as concise and interesting a form.

The authors have given considerable description of various types of equipment, for example, under "Flow of Heat" they speak of several different kinds of heaters; under "Evaporation" they describe not only the various evaporator designs but also evaporator accessories. Under "Extraction," Dorr agitators, Dorr thickeners, and diffusion batteries are treated; under "Filtration" considerable space is spent in describing the various types of filters, and the same thing is true in the chapters on "Mixing," "Crushing and Grinding," "Size Separation," in fact in practically all of the chapters of the book.

In brief, Professors Badger and McCabe should be congratulated on accomplishing exactly what they hoped to accomplish; that is, an elementary text on chemical engineering.

It is interesting to note that the physical unit operations of chemical engineering are growing more and more numerous. The chemical unit operations such as combustion, neutralization, sulfonation, nitration, etc., are also attracting the attention of the chemical engineer. The time may come when certain biological unit processes will be of importance to the chemical engineer. At the present time many of our famous and successful chemical engineers are those who are familiar not only with the methods of applications of chemistry, physics, and mathematics, but also the methods of applications of other sciences.

Badger and McCabe's book indicates very nicely that chemical engineering, after all, is not confined to the application of a science or a particular portion of a science but has to do largely with the application of many sciences to industrial problems.

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Industrial Research Laboratories of the United States, Including Consulting Research Laboratories. Bulletin of the National Research Council, Number 81. January, 1931. Compiled by CLARENCE J. WEST and CALLIE HULL for the Research Information Service of the Council. Fourth edition, Publication Office, National Research Council, Washington, D. C., 1931. 267 pp. 17 × 25 cm. $2.00.

The present, the fourth, revision of this useful list is illustrative of the growth of industrial research in this country since 1927. It shows a 60 per cent increase in the laboratories listed over those in the third edition (more than 1600 laboratories are included in this fourth edition as compared with about 1000 in the preceding edition). The material in the comprehensive alphabetical list relates to 1620 different companies and firms; it occupies 194 pages of the bulletin, and embraces the name and address of each organization, the principal products manufactured, the location of the laboratory, the size of the research staff, and usually a concise description of the nature of the investigational work conducted. This information was gleaned by a questionnaire that was sent to every known American industrial research laboratory, exclusive of laboratories connected with federal, state, or municipal governments, or with educational institutions. Accordingly the Bureau of Standards is not listed. Most concerns which are not actually supporting laboratories in their own plants have not been included, nor have most of the associations sustaining scholarships or fellowships in universities.

The list of laboratories is followed by three other sections: (1) addresses of directors of research (pp. 201–42); (2) geographical distribution of laboratories

(pp. 242–51); and (3) subject classification of laboratory activities (pp. 251–67). The first of these supplemental sections was not compiled with expected care; the other two sections are more satisfactory.

Viewing it in its entirety, this bulletin holds an unique and almost indispensable place among reference directories. Its principal defect is the evidence of the lack of critical editorial treatment that is seen throughout the list of laboratories. The answers to questions furnished by the directors of these establishments were properly assumed to be correct in point of fact; but the compilers should have exercised more license in editing these statements, so as to maintain uniform style, accurate terminology, and desirable fairness. To illustrate: it is not proper to say that a certain consultant has a "well-organized" staff, even though he thinks so; it is also improper for the compilers to give such prominent mention of a product as occurs in the case of a well-known flour (on p. 82); the misspelling of a consultant's name is particularly regrettable (*e. g.*, see 644 on p. 88); one laboratory (a commercial establishment) is said to have twelve "experts" on its staff (specialists are of course referred to); and, in several instances, a control laboratory has been clearly confused with a research laboratory.

Some of the laboratory staffs of small size must be kept very busy indeed in coping with the comparatively vast quantity of investigational work that is referred to. Most of the companies listed, however, have been modest in this respect, and apparently only a very few of them have made actual mis-statements of fact in their answers. There is an error on p. 75 (in item 564) and a similar one on p. 113 (in item 868): Mellon Institute has not been working in these fields for a number of years. Several prominent research laboratories are not included, but, in general, the list seems to be quite complete.

It is to be hoped that such inaccuracies and lack of balance will be finally eliminated in the fifth edition. The compilers' obligations in the next revision would be greatly facilitated if their work could be supervised by an advisory board of specialists thoroughly acquainted with the province of industrial research. The importance of the subject would surely justify this arrangement.

This bulletin is of much interest to chemical educationists for the following reasons: (1) Its subject classification of laboratory activities enables the easy finding of the names and addresses of specialists in the various branches of technology, from whom information, literature, and exhibits may be requested. (2) Its section on the geographical distribution of laboratories is of value in planning industrial inspection trips for students. (3) It is, in general, a helpful guide in aiding students to plan for their professional careers in the industries. In particular, it provides the basic information that is needed in quests for industrial positions for students and alumni. (4) It is a source-book of inspiring factual information and statistics regarding opportunities for young chemists in the industries.

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MISCELLANEOUS PUBLICATIONS

Predicting the Scholastic Success of College Students. CHARLES W. ODELL, Assistant Director, Bureau of Educational Research, University of Illinois. *Bulletin* No. 52, Sept. 30, 1930. Published by the University of Illinois, Urbana, Ill. 43 pp. 10 tables. 15 × 23 cm. $0.30.

This bulletin is the final report on a study of a group of several thousand high-school seniors in Illinois who have been followed through college or until they discontinued their collegiate training. The collection of the data extended over a period of five years.

The report includes the following: the prediction of college marks from the data available at college entrance, the prediction of marks during the last three years of college from data available at the end of the freshman year, the relationship between persistence in college and various other data, the relationship between size of high school attended and college success, and numbers of semester hours of different subjects and groups of subjects carried by four-year students.

The conclusions presented in this report should be of interest to those who are called upon to advise high-school graduates with reference to attending college and to those who advise college students.

Accredited Higher Institutions, 1929-1930. ELLA B. RATCLIFFE, Chief Educational Assistant, Division of Colleges and Professional Schools, Office of Education. U. S. Dept. of the Interior, *Bulletin*, 1930, No. 19. U. S. Government Printing Office, Washington, D. C., 1930. vi + 156 pp. 15 × 23 cm. $0.20.

Secondary Education in Norway. GABRIEL E. LOFTFIELD, Mount Vernon Junior College, Washington, D. C. U. S. Dept. of the Interior, *Bulletin*, 1930, No. 17. U. S. Government Printing Office, Washington, D. C., 1930. ix + 112 pp. 15 × 23 cm. $0.20.

Medical Students Need Brains, Mathematics, English. Medical students must be equipped with brains and a knowledge of mathematics and English, Dr. Wilburt C. Davison, dean of Duke University School of Medicine, Durham, N. C., said recently in Chicago at the congress on medical education held under the auspices of the American Medical Association.

Besides these essentials he advised greater premedical training in physics and chemistry. The matter of brains can best be judged by personal interview, he said. Academic records alone, no matter how excellent, are no longer the sole basis for admission to medical school. Dr. Davison doubts the necessity for four years of college work before entering medical school. Culture is more likely to be acquired during the early years in the home than from four years at college. He pointed out that the modern high school provides nearly as broad an education as was given by colleges in 1893 when The Johns Hopkins University first made a college degree a requirement for entrance to medical school. The knowledge of French and German obtained from most college courses is so superficial as to be almost useless to the medical student. If he must read scientific literature in foreign journals, he will get the knowledge anyway, Dr. Davison believes.

Examinations play a much bigger part in European medical schools than in American ones, Dr. Willard C. Rappleye, recently appointed dean of Columbia University College of Physicians and Surgeons, New York, said. Dr. Rappleye told results of a personal survey he has recently made of the subject.

In Germany, final examinations extend over about eight weeks for each student, and about one-fifth of the students fail. Examinations are uniform throughout the country, so students are allowed to go from one university to another, taking examinations where they please.

However, few students are unable to finish the medical course if they are persistent. Nearly all the examining bodies allow several trials and few universities are willing to make a failure final. The student is left much more on his own than in the American medical schools where there is more attention to the medical curriculum and fewer examinations.—*Science Service*

AN INDEX TO BOOK REVIEWS IN 1930

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This article is the second[1] in a series of annual indexes of book reviews which are compiled to list the most important recently published books of interest to chemists and to give references where information about these books may be obtained. In general references have been given for books which actually have been reviewed. An exception was made in the case of educational books because very few of them have been discussed critically in the standard chemical journals.

The index consists of two parts: (1) Subject Index and (2) Author Index. The Subject Index has been subdivided into the following sections:

A: Analytical
B: Biological
C: General, Inorganic, and Physical
D: Industrial Chemistry and Chemical Engineering
E: Historical
F: Organic
G: Popular
H: Bibliographical
I: Educational
J: Physics
K: Miscellaneous Texts

The Author Index follows the Subject Index and consists of an alphabetical list of the authors, each followed by the section letter, in boldface type, and item number in the Subject Index where the publication of the author may be found. For example ABDERHALDEN, E., **B**44 means that in section **B: Biological,** item 44, will be found information, including title and references to reviews, concerning a book of Abderhalden's.

The same book may be listed more than once in the same section or in several sections. In no case, however, are the complete title, the author's name, and the references given more than once. The cross references, which are printed in italics, are abbreviated and refer the reader to the complete reference.

The following journals have been consulted in the compilation of the index, the number in italics being used in the index to designate the corresponding journal:

(*1*) JOURNAL OF CHEMICAL EDUCATION, vol. **7.**
(*2*) *Journal of the American Chemical Society,* vol. **52.**
(*3*) *Journal of Physical Chemistry,* vol. **34.**
(*4*) *Industrial and Engineering Chemistry,* vol. **22.**
(*5*) *Chemical and Metallurgical Engineering,* vol. **37.**
(*6*) *Journal of the Association of Official Agricultural Chemists,* vol. **13.**
(*7*) *Metals and Alloys,* vol. **1,** numbers 7–18, incl.

In a number of cases, reviews of a book have appeared in 1929 as well as in 1930. The reviews of 1929 are indexed in last year's list.[1] In all these cases the reader is referred to the first index for the reviews of 1929.

[1] SCHEFLAN, "An Index to Book Reviews in 1929," J. CHEM. EDUC., **7,** 1454–82 (June, 1930).

Such an earlier review is indicated by the number (*8*) followed by the page, the section letter, and the item number.

The abbreviations of the months used are: Ja, F, Mr, Ap, My, Je, Jy, Ag, S, O, N, D.

The following examples will indicate the form in which the items are indexed.

A: Analytical

76 Volumetric Analysis, Vol. II. Practical Volumetric Analysis, I. M. KOLTHOFF AND N. H. FURMAN, (*4*)Ja104, (*6*)My293, (*8*)1456A41.
77 *Waxes, Analysis of—See* A8.

In item 76 the (*4*) refers to *Industrial and Engineering Chemistry*, Ja to the January, 1930, issue of that journal, and the 104 is the page number. Likewise, a review of this book appears in (*6*), the *Journal of the Association of Official Agricultural Chemists*, in the May, 1930, issue on page 293. Reference to more book reviews can be found in (*8*), J. CHEM. EDUC., vol. 7, June, 1930, on page 1456 under the item number A41. In item 77, the A8 refers to the same section, item 8, which happens to be in this case

8 Analyse der Fette und Wachse (Analysis of Fats and Waxes), A. GRÜN AND W. HALDEN, (*4*)Mr305.

The compiler will appreciate greatly any criticism, corrections, and suggestions for improving this index.

SUBJECT INDEX

A: Analytical

1 *Aconite Alkaloids, Analysis of—See* A3.
2 *Alkaloids, Analysis of—See* A3.
3 Allen's Commercial Organic Analysis, 5th ed., Vol. VII, Vegetable Alkaloids, C. A. MITCHELL, (*6*)F150, (*8*)1455A2.
4 *do.* Vol. VIII, (*4*)D1414.
5 *Alloys, Analysis of—See* A61.
6 *Amino Acids, Analysis of—See* A4.
7 Analyse der Azofarbstoffe (Analysis of Azo Dyes), A. BRÜNNER, (*4*)F197.
8 Analyse der Fette und Wachse (Analysis of Fats and Waxes), A. GRÜN AND W HALDEN, (*4*)Mr305.
9 Analyse der Harze, Balsame und Gummiharze (Analysis of Resins, Balsams, and Gum Resins), 2nd ed., K. DIETRICH AND E. STOCK, (*4*)Je687.
10 Analyse des Metauz pas Electrolyte (Electro-Analysis of Metals), 4th ed., A. HOLLARD AND L. BERTIAUX, (*7*)Je578.
11 *Analytic Chemistry, Annual Progress of—See* C17.
12 *Animal Acids and Bases, Analysis of—See* A4.
13 *Applied Inorganic Analysis—See* A34.
14 *Automobile Steels, Analysis of—See* D53.
15 *Azo Dyes, Analysis of—See* A7.
16 *Bearing Metals, Analysis of—See* A61.
17 *Berberine, Analysis of—See* A3.

18 *Caffeine, Analysis of—See* A3.
19 *Chocolate, Analysis of—See* A3.
20 *Cinchona Alkaloids, Analysis of—See* A3.
21 *Coal, Analysis of—See* A37, A39, A65, D499, D514.
22 *Cocaine, Analysis of—See* A3.
23 *Cocoa, Analysis of—See* A3.
24 *Coffee, Analysis of—See* A3.
25 *Coke, Analysis of—See* A37, D514.
26 Detection and Investigation of Poisons by Spectroscopy, The—, A. HILGER, (*1*)Mr 726.
27 *Electro-Analysis of Metals—See* A10.
28 *Enzymes, Analysis of—See* A4.
29 *Fats, Analysis of—See* A8.
30 Gas Analysis, 2nd ed., L. M. DENNIS AND M. L. NICHOLS, (*1*)Ap950, (*4*)Ja103, (*5*)Mr173.
31 *Glucosides, Analysis of—See* A4.
32 *Graphite, Analysis of—See* A61.
33 *Heavy Chemicals, Analysis of—See* D573.
34 Inorganic Analysis, Applied—, with Special Reference to the Analysis of Metals, Minerals, and Rocks, W. F. HILLEBRAND AND G. E. F. LUNDELL, (*1*)Ja217, (*4*)Ja 105, (*6*)My292, (*8*)1455A9.
35 *Leather, Analysis of—See* D115.
36 *Metals, Analysis of—See* A10, A34, A61, A65.
37 Methods for the Sampling and Analysis of Coal, Coke, and By-Products, 3rd ed., UNITED STATES STEEL CORPORATION, (*4*)F197.
38 Microanalysis, Quantitative Organic—, 2nd English ed., from the 3rd German ed., F. PREGL AND E. FYLEMAN, (*4*)D1413.
39 Microscopical Examination of Coal, The—, C. A. SEYLER AND W. J. EDWARDS, Department of Scientific and Industrial Research, Great Britain, (*4*)Jy810.
40 Mikroanalyse, Die Quantitative Organische—(Quantitative Organic Microanalysis), 3rd ed., F. PREGL, (*1*)N2755.
41 *Minerals, Analysis of—See* A34, A61, A65.
42 *Nicotine, Analysis of—See* A3.
43 *Oils, Analysis of—See* D226, F4.
44 *Opium Alkaloids, Analysis of—See* A3.
45 *Ores, Analysis of—See* A61, A65.
46 *Organic Analysis—See* A3, A4, A40, D341.
47 *Petroleum, Analysis of—See* A74.
48 *Poisons, Analysis of—See* A26.
49 *Proteins, Analysis of—See* A4.
50 *Putrefaction Bases, Analysis of—See* A4.
51 Qualitative Analysis, C. J. BROCKMAN, (*1*)My1217.
52 Qualitative Analysis, A Laboratory Manual of—, F. W. MILLER, (*1*)S2212.
53 *Qualitative Analysis—See* A67, C19.
54 *Qualitative Analysis by Means of X-Rays—See* C25.
55 Qualitative Chemical Analysis, Inorganic—, A. R. DAY, (*1*)Jy1723, (*5*)Jy438.
56 *Quantitative Analysis by Means of X-Rays—See* C25.
57 Quantitative Analysis, Elementary—, C. J. ENGELDER, (*1*)Ap953.
58 Quantitative Analysis, Introduction to—, E. J. MAHIN, (*1*)Ja217.
59 *Quantitative Microanalysis—See* A38, A40.
60 *Quantitative Volumetric Analysis—See* A76.

61 Rapid Methods for the Chemical Analysis of Special Steels, Steel Making Alloys, Their Ores, Graphites, and Bearing Metals, 4th ed., C. M. JOHNSON, (*4*)D1413, (*5*)O638.
62 *Refractories, Analysis of—See* A65.
63 *Rocks, Analysis of—See* A34.
64 *Rubber, Analysis of—See* D292.
65 Select Methods of Metallurgical Analysis, W. A. NAISH AND J. E. CLENNELL, (*1*)Ap955, (*2*)O4177, (*7*)F397.
66 *Slags, Analysis of—See* A65.
67 Solutions of Electrolytes with Particular Application to Qualitative Analysis, L. P. HAMMETT, (*1*)Ja218, (*5*)F109, (*8*)1456A33.
68 *Steel, Analyses of—See* A61, A65.
69 *Strychnos Alkaloids, Analysis of—See* A3.
70 *Sugar, Analysis of—See* D85.
71 *Tea, Analysis of—See* A3.
72 *Tobacco, Analysis of—See* A3.
73 *Tropine Alkaloids, Analysis of—See* A3.
74 Untersuchungsmethoden der Erdölindustrie (Methods of Analysis in the Petroleum Industry), H. BURSTIN, (*4*)My566.
75 *Vegetable Alkaloids, Analysis of—See* A3.
76 Volumetric Analysis, Vol. II. Practical Volumetric Analysis, I. M. KOLTHOFF AND N. H. FURMAN, (*4*)Ja104, (*6*)My293, (*8*)1456A41.
77 *Waxes, Analysis of—See* A8.

B: Biological

1 *Adsorption and Vital Phenomena—See* B10.
2 *Bacteria—See* B6, B54.
3 *Bacteria and the Development of a Practical Technic for the Chemical Analysis of Cells, Chemistry of—See* C67.
4 *Bacterial Life, Chemistry and Physics of—See* B5.
5 Bacterial Metabolism, M. STEPHENSON, (*1*)Je1449.
6 Bacteriology. A Textbook of Fundamentals, 2nd ed., S. THOMAS, (*4*)O1140.
7 *Biocatalysts—See* B65.
8 *Biochemistry—See* B44, B65, B76.
9 *Biocolloids—See* B44.
10 Biological Aspects of Colloidal and Physiologic Chemistry, Lectures on—, W. B. SAUNDERS CO., (*1*)F485.
11 *Biologic Changes during the Storage of Meat, Fish, and Fruits at Low Temperature—See* B83.
12 *Biologic Constants and Data—See* K47.
13 *Biologic Methods—See* B44.
14 *Biology—See* B14, B50, F124.
15 Biophysics, An Introduction to—, 2nd ed., D. BURNS, (*3*)Ja217.
16 *Blood Serum as a Colloidal System, Human—See* C67.
17 Bodenkomplex und die adsorbierten Bodenkationen als Grundlage der genetischen Bodenklassifikation, Der adsorbierende— (The Adsorbing Soil Complex and the Adsorbed Cations of the Soil as a Basis for the Genetic Classification of Soils) K. K. DEGROIZ, H. KURON, AND P. EHRENBERG, (*2*)My2158.
18 *Bread—See* G5.
19 *Canned Foodstuffs and Hydrogen Ions—See* D308.
20 *Carbohydrates—See* B65.
21 *Catalysts, Bio- —See* B65.

22 *Cellular Mechanics—See* **B15.**
23 Chemical Action of Microörganisms on the Non-Nitrogenous Organic Compounds, An Index to the—, E. I. FULMER AND C. H. WERKMAN, (*2*)S3745, (*4*)Jy811, (*5*)My 376.
24 Chimica Farmaceutica e Tossicologica, Inorganic ed Organica (Pharmaceutical and Toxicological Chemistry, Inorganic and Organic), B. ODDO, (*2*)S3743.
25 *Colloid Chemistry in Biology and Medicine—See* **B10.**
26 *Colloids in Biology and Medicine—See* **B50.**
27 *Colloid State of Matter—See* **B65.**
28 *Community Health—See* **B66.**
29 Dairy Chemistry, A Textbook of—, E. R. LING, (*1*)D3025.
30 *Dairy Practice—See* **D413.**
31 Dietetics and Nutrition, M. A. PERRY, (*1*)D3024.
32 *Dietetics, Introduction to—See* **B87.**
33 *Diet, Normal—See* **B63.**
34 *Digestion, Physiology of—See* **B39.**
35 *Disinfection and Disinfectants—See* **B66.**
36 *Enzymes—See* **B15.**
37 Essentials of Chemical Physiology, The—, 12th ed., W. D. HALLIBURTON, J. A. HEWITT, AND W. ROBSON, (*1*)Ap955.
38 *Fats—See* **B65.**
39 Feeding the Family, 3rd ed., M. S. ROSE, (*1*)N2753.
40 *Fermentation—See* **B5, G5.**
41 *Flour—See* **G5.**
42 *Food—See* **B39, B66, B83, B85, D38, D308.**
43 Green Manuring, A. J. PIETERS, (*6*)F148.
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Brazing Replacing Soldering in Electrical Industry. Blow torch and soldering iron, essential tools of the electrical worker for years, are becoming obsolete. Brazing is taking the place of soldering: silver is being substituted for lead. Thus is summarized the change which is now coming over a fundamental practice of the electrical industry, that of connecting together two wires or two electrical conductors. The process of brazing was described recently before the American Institute of Electrical Engineers by Samuel Martin, Jr., of the General Electric Co.

In spite of the fact that brazing makes use of the coin metal, silver, instead of cheap lead used in soldering, Mr. Martin said that the newer process is actually cheaper than soldering. The equipment needed is a step-down transformer, a foot switch and tongs in which to hold the pieces to be brazed. Two carbon blocks on the ends of each branch of the tongs make the connection with the pieces to be brazed.

"The carbon electrodes heat up quickly," Mr. Martin explained, "and the heat passes from them into the parts being joined, raising their temperature to the melting point of the brazing alloy. The alloy, in the form of a thin strip for convenience, is then applied to the contact surfaces of the parts being brazed. It melts and flows through the joints uniting the parts in a solid mass."

A brazed joint is preferred to a soldered connection, it was explained, because it is stronger and cheaper, has greater conductivity and higher heat-resisting qualities, and takes less time to make.—*Science Service*

Opportunities. Lord Moynihan, former president of the Royal College of Surgeons, recently remarked, in addressing the British Medical Association, that Lord Lister was the greatest material benefactor the world has ever known and that he had "saved more lives than all the wars of all the ages have thrown away."

The speaker might have also remarked that these marvelous results were obtained by the use of a chemical compound (phenol) already long known to chemists.

The speaker would probably have also been justified in remarking that the introduction of surgical anesthesia had brought relief from more pain than had been inflicted in all the wars of all the ages. Here again this result followed the use of a chemical compound (ether) well known to chemists for 300 years before the medical profession learned to use it as an anesthetic.

Numerous other illustrations of this kind could be cited: the Rockefeller Foundation, for example, boasts of having cured more than 10,000,000 human beings of the hookworm disease largely through the use of another compound, carbon tetrachloride, already known to chemists for almost a century before health officials learned from a veterinarian its value.

Malaria may be cured or prevented by quinine, syphilis and yaws by mercury and arsenic, amebic dysentery by emetine; every form of pain—from the mildest headache to the agonizing pain of angina pectoris—every form of convulsions (epilepsy, tetanus) may now be relieved by chemical compounds.

Most of these advances have resulted from the pharmacological investigation of perhaps less than 10,000 of the more than 260,000 organic compounds known to chemists; what advances might result from even a superficial study of the other 250,000 compounds no one could predict.

Of course, theoretically, it is the function of the medical schools and the richly endowed medical research institutes to investigate the possibilities in this field, but experience has shown that the medical profession is so engrossed in the problems of the individual patient that there is little time for pioneer exploratory work. Hence clear leads for the possible chemical control of one of the present greatest scourges of mankind (cancer) are not being followed up; in fact, eminent "authorities" on cancer recently demonstrated (to their own satisfaction) that any control of cancer through drugs is impossible just as the most eminent surgeons two or three years before the introduction of surgical anesthesia by ether had demonstrated (to their own satisfaction) that the hope of finding a drug which would produce this effect was a "chimera."

Illogical as it is, it may be necessary for the chemists to take the lead in this field—just as they did in showing the practical dyers the possibilities in the aniline dyes, the photographers the possibilities in the use of synthetic developers, etc.

The time may come when there will be attached to every chemical factory and every chemical research laboratory, a pharmacological laboratory, the function of which will be the investigation of the therapeutic possibilities of the chemical compounds discovered. The dry cleanser or the manufacturer of a fire extinguisher a few years ago would probably have been greatly surprised to learn that he was daily using a compound which was destined soon to restore to health and useful activity 10,000,000 sick human beings.

In any case, the quarter of a million of chemical compounds known which have never been tested for medical properties—and about twenty new ones are being added to the list every day—offer wonderful opportunities for the realization of the day when the human body, like a famous vehicle, will go to pieces.

"All at once, and nothing first.

Just as bubbles do when they burst."—REID HUNT, *The Nucleus*, **8**, 32–4 (Nov., 1930).